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HON. CHARLES STEWART, MINISTER — CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
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Talc and Soapstone in Canada

BY
Hugh S. Spence

OTTAWA
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PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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TALC AND SOAPSTONE IN CANADA

CHAPTER I

INTRODUCTORY

In 1920, the year of maximum production, talc was produced in Canada to the amount of 21,671 tons, valued at $166,934. Practically the whole of the output in recent years has been derived from three mines and mills in the Madoc district, Hastings county, Ontario. The Madoc deposits yield a fine, white, foliated talc, that probably has no superior for certain purposes, and finds extensive employment in the paper, textile and toilet (talcum) powder trades. The known occurences of such talc in Canada are confined to the Madoc district.

Occurrences of off-colour talc, yielding ground products ranging in colour from cream to greenish-grey, are not uncommon in and adjacent to the serpentine belt of the Eastern Townships, in Quebec. Some of these deposits were worked a number of years ago for roofing talc, but no active exploitation has taken place for many years past. The talc of certain of these deposits compares very favourably in colour, slip, and chemical composition with the talc produced at the present time in the neighbouring state of Vermont; and while the talc bands are in many cases narrow, they appear to be fairly persistent. These deposits are of decided economic importance, and will undoubtedly be worked at some later date. It is probable, also, that active prospecting in this region would disclose other important bodies of talc suitable for the paper, rubber, and roofing trades.

Talc, similar in a general way to that of the Eastern Townships, Que., but more compact and fine-grained, occurs also in the Yale and Lillooet mining divisions of British Columbia.

Soapstone is a soft rock, composed largely, or in part, of talc. Many so-called soapstones, however, contain little or no talc, being merely soft, altered igneous rocks. Soapstone is of value for its resistance to heat, acids, and alkalies, and for the ease with which it can be cut into slab or block form. There is no record of any slab or block soapstone having been produced in Canada; though small quantities of massive talc or of chloritic or talc-slate have been taken out by operators of sulphate pulp mills for trial in the lining of their smelting furnaces. Practically the whole of the very considerable amount of soapstone consumed by Canadian kraft paper mills is imported from the United States.

This report contains the available data relating to talc and soapstone deposits in Canada, as well as a chapter on the uses of these materials, and an outline of talc milling methods.

ANALYSES OF CANADIAN TALCS AND SOAPSTONES AND OF SOME AMERICAN COMMERCIAL TALCS

All the analyses of talc and soapstone samples for this report were made in the Mines Branch laboratory, by A. Sadler.

For the purpose of reference and ready comparison, the analyses made have been grouped together below. Most of the samples of crude talc or soapstone analysed were collected by the writer. Mill products were furnished by operators, as representative of their material.

—	1	2	3	4	5
Silica	33·68	59·88	61·52	57·62	39·14
Ferrous oxide	4·97	4·54	0·66	5·31	8·79
Ferric oxide	none	none	0·24	0·80	3·48
Alumina	1·65	1·18	none	2·46	7·32
Lime	15·32	0·10	0·10	0·10	5·92
Magnesia	22·68	29·51	32·63	28·53	21·31
Carbon dioxide	18·23	0·02	0·07	none	7·31
Water above 105° C	3·20	4·73	4·39	4·75	6·68
Total	99·73	99·96	99·61	99·57	99·95
Colour of ground product [1]	Dark grey	White	Snow white	Grey	Brown
Slip	Medium	Good	Good	Medium	Poor

[1] Colour comparison made against a standard sample of prime floated barytes.

1. Wolf creek, Victoria mining division, Vancouver island, B.C.
2. Gisby claims, near Keefers, Yale mining division, B.C.
3. Banff Talc Company's claims, Windermere mining division, B.C.
4. Pacific Roofing Company's claim, Lillooet mining division, B.C.
5. Soft, chloritic slate, near Kenora, Lake of the Woods, Ont.

—	6	7	8	9	10
Silica	51·44	41·94	54·62	52·50	50·64
Ferrous oxide	7·24	7·71	1·41	0·28	0·79
Ferric oxide	3·68	2·05	0·88	0·10	0·55
Alumina	4·79	7·57	0·09	0·17	1·06
Lime	none	3·42	4·90	9·26	4·84
Magnesia	26·43	25·39	28·56	26·04	30·49
Carbon dioxide	0·11	5·09	4·59	6·85	5·21
Water above 105° C	6·56	6·71	5·01	5·13	6·26
Total	100·25	99·88	100·06	100·33	99·84
Colour of ground product	Dark grey	Dark grey	Dark	White	Brown
Slip	Medium	Poor	None	Poor	None

6. Soapstone, wall zone, Wabigoon, Ont.
7. Soapstone, main body, Wabigoon, Ont.
8. Altered pyroxenite (rensselærite), Grindstone island, Rideau lake, Ont.
9. Caldwell property, E. ½ lot 24, concession III, Lavant township, Ont.
10. Altered pyroxenite (rensselærite), lot 35, concession III, Pittsburgh township, Ont.

—	11	12	13	14	15
Silica	53·92	51·00	49·48	49·28	56·32
Ferrous oxide	0·36	0·32	0·24	0·19	0·20
Ferric oxide	none	0·13	0·13	0·14	none
Alumina	0·32	0·62	0·82	0·41	0·06
Lime	5·02	6·98	7·02	7·06	2·36
Magnesia	29·63	28·76	29·11	29·21	31·72
Carbon dioxide	5·51	7·72	9·02	9·26	3·99
Water above 105° C	5·05	4·70	4·13	4·55	5·18
Total	99·81	100·23	99·95	100·10	99·83
Colour of ground product	White	White	White	White	White
Slip	Good	Good	Good	Good	Good

11. Crude talc, Henderson mine, lot 14, concession XIV, township of Huntingdon, Ont.
12. Mill product No. 1, Geo. H. Gillespie Company, Madoc, Ont.
13. Mill product No. 2, " " "
14. Mill product No. 3, " " "
15. Crude talc, Connolly mine, lot 15, concession XIV, township of Huntingdon, Ont.

—	16	17	18	19	20
Silica	30·80	51·86	59·66	54·88	59·62
Ferrous oxide	0·28	0·39	4·12	4·63	4·25
Ferric oxide	none	0·60	0·37	1·44	1·21
Alumina	0·65	1·54	1·67	3·59	1·40
Lime	16·68	10·04	none	1·10	none
Magnesia	24·57	18·19	29·26	27·22	28·49
Carbon dioxide	24·37	13·49	none	1·52	trace
Water above 105° C	2·67	3·33	4·90	5·86	4·61
Total	100·02	99·44	99·98	100·24	99·58
Colour of ground product	White	Dark	Grey-green	Grey-green	Grey-brown
Slip	Medium	None	Good	Good	Good

16. Crude talc, Eldorado Mining and Milling Company's mine, lot 20, concession V, township of Madoc, Ont.
17. Grey talc schist, lot 20, concession V, township of Madoc, Ont.
18. Schistose talc, lot 5, range V, township of Thetford, Que.
19. " lot 7, range V, "
20. " lot 9, range V, "

—	21	22	23	24	25
Silica	61·12	59·78	58·48	60·86	58·96
Ferrous oxide	3·16	3·96	3·64	1·11	1·01
Ferric oxide	0·20	0·44	1·04	0·24	0·58
Alumina	0·54	1·82	2·33	0·22	1·03
Lime	none	0·02	none	0·08	1·16
Magnesia	30·48	29·23	29·50	32·19	30·96
Carbon dioxide	none	0·02	none	0·09	0·85
Water above 105° C	4·58	4·79	4·97	4·50	5·48
Total	100·08	100·06	99·96	99·29	100·03
Colour of ground product	White	Grey-green	Grey-brown	Grey	Dark pink
Slip	Good	Good	Good	Good	None

21. Steatite, lot 23, range VI, township of Melbourne, Que.
22. Schistose talc, Pibus property, lot 26, range II, township of Bolton, Que.
23. Ground talc, lot 20, range II, township of Wolfestown, Que.
24. Foliated talc, lot 2, Craig's road range, township of Ireland, Que.
25. Altered pyroxenite (rensselærite), lot 26, range II, township of Grenville, Que.

—	26	27	28	29	30
Silica	58·88	60·52	56·86	43·80	55·50
Ferrous oxide	0·46	0·14	0·06	5·58	4·85
Ferric oxide	0·04	0·08	0·08	0·34	none
Alumina	0·81	0·82	0·67	1·64	2·71
Lime	1·80	4·12	4·12	0·24	1·26
Magnesia	31·74	28·05	31·12	31·35	29·40
Carbon dioxide	1·32	1·44	0·88	12·50	0·52
Water above 105° C	5·00	3·06	4·67	4·86	4·50
Total	100·05	98·23	98·46	100·31	98·74
Colour of ground product	Snow white	White	White	Grey	Grey
Slip	Good	Poor	Poor	Medium	Good

26. Steatite, Fraser's mill, Whycocomagh, N.S.
27. No. 1 mill product, International Pulp Company, Gouverneur, N.Y.
28. No. 1 mill product, W. H. Loomis Talc Corporation, Gouverneur, N.Y.
29. No. 1 mill product, Eastern Talc Company, Rochester, Vermont.
30. No. 1 mill product, Magnesia Talc Company, Waterbury, Vermont.

DISTRIBUTION OF DEPOSITS

The Canadian talc mining industry centres around Madoc and Eldorado, in Hastings county, Ontario, this district having produced practically all the talc mined in Canada since 1900. Previous to that time, small amounts of impure talc and soapstone had been produced from deposits in the Eastern Townships, Quebec, and in Leeds county, Ontario.

Soapstone and talc are known to occur at a number of localities in or adjacent to the serpentine belt of the Eastern Townships, bands of impure talc, usually quite narrow, being not uncommon in the serpentine proper, as well as in the altered basic intrusives (pyroxenites and chloritic talc, and greenstone schists) associated with it. Many of the talc bands grade into talc or chloritic schist. None of the soapstone seen would appear to be massive enough for use as slabs or blocks. It is possible, however, that the schistose talc of certain of the localities listed below might give place in depth to a more massive and compact material.

None of the Quebec talc deposits have been actively exploited, shallow prospect pits representing the only development work. In view of the occurrence of important economic bodies of talc and soapstone, associated with similar rocks, in the adjoining state of Vermont, it is at least possible that closer investigation of the Quebec area may disclose larger deposits of these materials than those mentioned in this report.

The principal talc deposits in Quebec lie in the townships of Bolton and Potton, in Brome county; Wolfestown, in Wolfe county; and Broughton, Thetford, Ireland and Inverness, in Megantic county. The bulk of the material secured from these deposits appears to have found employment in the manufacture of fireproof roofing materials.

The talc deposits of the Madoc district yield quite a different grade of talc to the foregoing, the ore consisting of medium to coarsely foliated talc of a light cream, almost white colour, and representing an alteration product of the white, metamorphic, crystalline magnesian limestone of the Pre-Cambrian. The deposits carry very little massive talc, or steatite, such as is commonly found as an alteration product of basic igneous rocks or of non-crystalline dolomites. Work on the Madoc deposits commenced about the year 1900, when the Henderson mine was opened, and crude ore was for some years shipped to the United States. In 1906, the first grinding mill in the district was erected at Madoc station, to grind ore from the Henderson mine. Both mine and mill have continued steadily in operation to the present time, and are the largest producers of crude and ground talc respectively in Canada.

The Henderson mine is situated on concession XIV, lot 14, of the township of Huntingdon, and was opened on a large lens of high grade, foliated talc, enclosed in crystalline dolomitic limestone. In 1912 the Connolly mine was opened on the adjoining lot to the east, and in 1915 was taken over by the Anglo-American Talc Corporation, Ltd., who in 1916 built a mill on the property and have continued mining and grinding operations to the present time. In 1917 the International Pulp Company carried out exploratory work, sinking two shafts and running several cross cuts on lot 16, in the same concession,

but abandoned operations the next year. The above three adjoining lots are the only properties upon which operations for talc have been conducted in the immediate vicinity of Madoc. In 1911 the Canadian Talc and Silica Company commenced mining, and erected a mill near the village of Eldorado, 8 miles north of Madoc. The company was re-organized in 1914 as Eldorite, Ltd., and again in 1918 as Eldorado Mining and Milling Company, Ltd. Mining and milling operations have been carried on intermittently to the present time.

The above three producing mines, each equipped with a grinding mill, have been the source of practically all the talc mined in Canada during the past twenty years. The great bulk of the talc produced has been ground on the spot, but a certain amount of crude ore has been shipped to the United States.

Talc is found also in British Columbia. The known deposits are mostly of the massive or steatite variety, and much of the material is impure and yields an off-colour product on grinding. There has been only a very small production from the deposits in the province, and practically the whole of it has been utilized in the roofing industry. The deposits examined were all rather narrow, and several of them would probably be difficult to mine on account of the loose nature of the talc itself and of the enclosing slate.

In Nova Scotia a small occurrence of steatite was worked many years ago near Whycocomagh, Inverness county, Cape Breton island. Neither this deposit, nor the other recorded occurrences of steatite in Cape Breton island, appear to be of economic importance.

Occurrences of altered igneous rocks, some of which approach soapstone in character, have long been known in the Pre-Cambrian of western and northern Ontario, particularly in the Lake of the Woods area and in the region around Hudson bay. The attention of observers was early directed to these occurrences by reason of the fact that the Indians and Eskimos frequently make pipes and pots from such material; and the early reports of the Geological Survey contain numerous references to localities from which the aboriginal inhabitants were stated to obtain their supplies of pipestone or potstone.

In this connection, it should be stated that much of the so-called pipestone or soapstone referred to in the earlier reports of the Geological Survey is probably not steatite or soapstone. Any soft rock, such as a soft slate or schist, serpentine, and many altered igneous rocks, may be used by Indians as pipe material. There is also a tendency, even to-day, to class any fine-grained, soft, chloritic, or sericitic slate or schist as pipestone or soapstone; even unaltered shale or slate may sometimes be recorded as soapstone (see Geol. Surv. Can., Rep. Prog., 1863-6, p. 244). The term pipestone, used in an adjectival sense, is to be found designating many rivers, lakes, islands, etc., in Canada to-day.

STATISTICAL

Production

The following table gives the annual production of talc and soapstone in Canada from 1886 to 1921. From 1886 to 1906 the figures relate principally to impure talc and soapstone, obtained for the most part from deposits in the Eastern Townships, in the province of Quebec. The steady increase in the figures of production from the year 1906 mark the opening up of the high grade deposits of talc in the Madoc district, in Ontario, and the establishment of the talc milling industry in that area. The Madoc talc is of a grade unsurpassed for many purposes where pure white, high-class talc is required, such as in the paper and textile industries and in the manufacture of cosmetics, soaps, etc. The bulk of the Madoc talc finds employment in this way. While most of the Madoc talc mined is ground locally a certain amount is also shipped crude to consumers in the United States.

Talc and Soapstone Mined in Canada, 1886 to 1921*

Year	Tons	Value	Year	Tons	Value
		$			$
1886	50	400	1904	840	1,875
1887	100	800	1905	500	1,800
1888	140	280	1906	1,234	3,030
1889	195	1,170	1907	1,534	4,602
1890	917	1,239	1908	1,016	3,048
1891	0	0	1909	4,350	10,300
1892	1,374	6,240	1910	7,112	22,308
1893	717	1,920	1911	7,300	22,100
1894	916	1,640	1912	8,270	23,132
1895	475	2,138	1913	12,250	45,980
1896	410	1,230	1914	10,808	40,418
1897	157	350	1915	11,885	40,554
1898	405	1,000	1916	13,104	49,423
1899	450	1,960	1917	15,803	76,539
1900	1,420	6,365	1918	18,169	119,197
1901	259	842	1919	18,642	116,295
1902	689	1,804	1920	21,671	166,934
1903	990	2,739	1921	7,916	32,456

*Mineral Production of Canada, Annual Reports, Mines Branch.

The figures of value in the above table up to the year 1917 and for the year 1921 refer to the spot value of the crude talc. For the four year period 1917-1920, the figures of value refer to both crude and ground talc. The lack of uniformity in the manner of quoting figures of value is occasioned by the fact that the largest grinder of talc in the Madoc district (Geo. H. Gillespie Co., Ltd.) buys crude talc, while the other concerns operating grinding mills in the district secure their ore from their own mines.

Production of Crude and Ground Talc in Canada, 1917-20

	1917		1918		1919		1920	
	tons	$	tons	$	tons	$	tons	$
Crude (a)	13,184	51,856	12,772	47,494	12,243	49,074	11,820	48,939
Ground (b)	2,619	24,683	5,397	71,703	6,399	67,221	9,851	117,995
Total	15,803	76,539	18,169	119,197	18,642	116,295	21,671	166,934
Total ground talc sold (c)	13,703	171,788	15,903	222,167	15,927	235,000	19,610	303,738

(a) Crude talc shipped, the product of all mines.
(b) Ground talc produced by mills run in conjunction with mines.
(c) Total ground talc produced by all mills.

Exports

Crude and ground talc have been separated in the list of exports only since 1920. All the crude talc exported is consigned to the United States, the figures for 1920 and 1921 being:—

1920—1,072 tons valued at $6,321.

1921—71 tons valued at $437.

Previous to April, 1917, talc exports were included with those of magnesite and feldspar. The exports of ground talc in 1920 and 1921 are shown below:—

Exports of Ground Talc, 1920 and 1921*

Year	United States		Other countries		Total	
	tons	$	tons	$	tons	$
1920	15,006	255,249	163	2,138	15,169	257,387
1921	6,986	111,776	22	277	7,008	112,053

*Trade of Canada.

In 1918 exports of talc (both crude and ground, to all countries) were valued at $208,301. In 1919 crude and ground talc exports to the United States totalled $206,705, and to other countries $3,445, a total of $210,150.

Imports

Imports of talc have not been separately recorded since 1915. The imports, 1913 to 1915, were:—

——	Tons	$
1913	402	10,706
1914	584	8,983
1915	154	1,866

Talc imported into Canada includes ground talc for use in the paper, rubber, paint, and roofing trades, and crude, lump, red talc to be ground up for use in foundry facings. In addition, so-called Alberene stone (a soft, altered, igneous rock, sometimes classed as a soapstone) is imported in some quantity for lining the smelting furnaces of sulphate pulp mills.

Import Duty.—There is no import duty on crude talc and soapstone entering Canada. The British preferential tariff on ground talc and soapstone, and on cut, slab, or block talc and soapstone, is 15 per cent ad valorem, and the intermediate and general tariff, 17½ per cent.

The present duty on prepared (cut, powdered, washed or pulverized) talc entering the United States is 15 per cent ad valorem. There is no tariff on crude talc.

A bill to increase the present import tariff on talc and soapstone entering the United States is at present before the Committee of Ways and Means of the House of Representatives. The proposed new tariff provides as follows:—

Talc, steatite, soapstone, and French chalk—

Crude and unground, ½ cent per pound.

Ground, washed or powdered, 1 cent per pound.

Cut or sawed into blanks, crayons or cubes, 2 cents per pound.

Manufactures of, not decorated, 50 cents ad valorem.

Manufactures of, decorated, 60 per cent ad valorem.

Consumption of Talc and Soapstone in Canada and the United States

CANADA

According to a recent survey of the Dominion Bureau of Statistics of the principal industries in Canada using talc and soapstone, the consumption of these materials in 1920 and 1921 was as follows:—

Consumption of Talc and Soapstone in Canada in the Principal Consuming Industries

POWDERED TALC AND SOAPSTONE

Source	1920				1921			
	Canada		United States		Canada		United States	
	Pounds	$ *a*	Pounds	$ *a*	Pounds	$ *a*	Pounds	$ *a*
Industry—								
Foundry (incomplete)	9,919	296	....	....	10,472	321	....	....
Paint	134,507	1,626	1,864,167	26,071	118,601	1,590	1,047,284	15,833
Paper	2,906,565	23,951	1,302,160	12,121	2,872,576	24,702	735,000	5,760
Roofing	1,577,000	10,262	389,400	3,479	988,817	7,659	279,000	2,493
Rubber	346,477	4,512	815,211	7,548	187,622	2,456	286,412	2,905
Soap	100,839*b*	1,111*b*	....	....	197,778*b*	3,452*b*	....	....
Foundry facings *c* (incomplete)	102,000	539	180,000	1,005	8,400	66	83,700	828

a Figures of value relate to the cost laid down at the plant.
b Country of origin not known.
c There is an overlapping with returns received from foundries.
Compiled from information furnished by Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics.

Consumption of Talc and Soapstone in Canada in the Principal Consuming Industries—*Con.*

BLOCK SOAPSTONE

—	1920				1921			
	Canada		United States		Canada		United States	
	Cu. ft.	$	Cu. ft.	$	Cu. ft.	$	Cu. ft.	$
Paper pulp (sulphate)	....	....	16,237	87,169	....	....	15,015	84,124

The actual totals of consumption are probably slightly higher than as shown in the tables, since the textile industry, as well as several minor consuming industries, do not figure in the list.

According to a survey made in 1913,[1] the consumption in Canada of talc and soapstone by the principal industries was as under:—

Consumption of Talc and Soapstone in Canada in 1912*

Location	Number of firms	Domestic	Imported
		tons	tons
Maritime Provinces	13	½	36
Quebec	28	2,811	233
Ontario	118	1,282	487
Prairie Provinces	10	82	3
British Columbia	2	50	½
Total	171	4,225	759

*The figures do not actually relate specifically to any particular year, but should rather be taken as representing the annual average, 1911 to 1913.

[1] H. Fréchette, Non-Metallic Minerals Used in the Canadian Manufacturing Industries, Mines Branch, Ottawa, 1914, p. 103.

United States

Preliminary figures[1] indicated the talc consumption in the United States in 1920 to be as follows:—

——	Tons	$	Value per ton
			$
Domestic	213,000	2,360,000	11·00
Imported	24,000	475,000	20·00
Total	237,000	2,835,000	

Of the imported talc, 70 per cent came from Canada, 20 per cent from Italy, and the remainder from France, India, Austria, Germany, and Sweden. The Canadian talc had an average declared value of $16 per ton, the Italian $35, French $15, and Indian $50 per ton.

With regard to talc-grinding capacity in the United States, Ladoo (16) observes that towards the close of 1920, new plant capacity, either building or projected, totalled nearly 500 tons per day, this tonnage being divided among nine operators, and bringing the estimated total talc-grinding capacity of the country to about 710 tons per day. While increased grinding capacity is doubtless justified to some extent by normal increase in demand, and while a proportion of the new capacity will probably merely replace that of older and less efficient mills, Ladoo is of opinion that the already established grinding capacity is more than sufficient to take care of the normal needs of the country, and that further expansion at the present time is unwarranted.

[1] Ladoo, R. B., The Talc Industry in 1920, U.S. Bureau of Mines Reports of Investigations, January 1921 (15).

CHAPTER II

MINES AND OCCURRENCES

BRITISH COLUMBIA

Windermere Mining Division

A deposit of massive talc, or steatite, occurs at the base of Mount Whymper, near Vermilion Summit, eleven miles south of Castle station on the main line of the Canadian Pacific railway. The deposit is on what is known as the Silver Moon claim, registered as Lot 11708 G1, and lies a few hundred yards north of the new Castle-Windermere highway. The property consists of 51 acres, and was taken up some years ago by the Banff Talc Company, which carried out a small amount of prospecting work and opened a few shallow pits. No further mining has been done. The present owners are represented by B. S. Fox, Banff, Alta.

The talc is uniformly massive and has a light, yellowish-green colour. Most of the samples examined have a tendency to check rather badly, and much of the material collected around the outcrops was found to be badly flawed. Test pieces, after burning at 1000°C., were found to be badly checked. The talc does not appear suitable, therefore, for lava purposes.[1] This tendency to check may, however, be less pronounced in the deeper lying portions of the deposit.

The talc occurs in the form of several irregular pockets or chimney-like bodies, enclosed in a grey, horizontally bedded dolomite. All the talc bodies uncovered occur at approximately the same horizon in the dolomite. They vary in width from 15 to 20 feet, the maximum vertical extent being 75 feet.

The present workings do not indicate the existence of any single large body of talc, but point rather to a number of isolated, pockety, replacement bodies in the dolomite.

The talc usually contains an appreciable amount of quartz, both massive, as stringers, and in the form of small, well-shaped crystals. Crystals of dolomite also occur in it. These minerals appear to occur chiefly near the contact of the talc bodies with the dolomite.

A sample of selected material, free from quartz and dolomite, analysed in the Mines Branch laboratory, yielded:—

Silica	61·52
Ferrous oxide	0·66
Ferric oxide	0·24
Alumina	none
Lime	0·10
Magnesia	32·63
Carbon dioxide	0·07
Water above 105° C	4·39
	99·61

The analysis shows the material to be a remarkably pure steatite, approximating closely the theoretical composition of talc.

[1] For explanation of this term see page 53.

Further analyses of this steatite, given in the Annual Report on the Mineral Resources of Alberta, II, 1920, p. 123, are:—

—	1	2
Silica	64·06	62·91
Iron oxide	....	1·68
Alumina	2·10	....
Lime	....	....
Magnesia	30·13	31·12
Soda	1·78	1·17
Water	1·41	1·53
	99·48	98·41

1. Analysis by Industrial Laboratory, University of Alberta.
2. Analysis furnished by owner.

The water content shown by these two analyses is only about one-third of the theoretical amount required by the magnesia and silica present to form talc.

The colour of the talc when ground is a good white.

J. Serra, also of Banff, Alta., has taken up the adjoining claim to the west of the above, but has done no mining.

Yale Mining Division

A group of five claims, known as the Gisby group, were taken up in 1919 by Talc Products, Ltd., Vancouver, B.C. In 1920 the B.C. Silica and Talc Company, Rogers building, Vancouver, took over the properties and worked a short time on a royalty basis.

The claims lie 3 miles west of Keefers station on the main line of the Canadian Pacific railway, on the north side of the track, and abut on the railway. The present shipping point is Chaumox, the next station west, distant two miles by wagon road. Only quartz had been shipped up to the time of the writer's visit in October, 1920, this mineral being consigned to the operators' grinding mill at New Westminster.

Both talc and quartz occur on the property, the deposit of the latter being probably the more important. The quartz is uniformly white, opaque, and very clean, and occurs as a persistent band, striking northwest and outcropping for a distance of over a mile, with an average width of 25 feet.

The country rock is grey to green talc slates, tilted almost vertical, and the quartz and talc bodies both occur conformably in the slates. The quartz has possibly been introduced subsequent to the laying down of the enclosing slates, but the talc body represents merely an extremely altered zone of the country rock, the alteration to talc probably being due to the action of mineralizing solutions on and adjacent to a slip plane. The uptilting of the strata has been attended by a considerable degree of jointing and squeezing of the slates, and the talc body itself is much jointed and squeezed. As a result, little of the talc comes out in the form of compact blocks of any size, the material breaking up into irregularly shaped pieces with slickensided surfaces.

The talc body is exposed in a tunnel, driven in search of gold through the practically vertical slates, at right angles to their strike, and was struck at a distance of 150 feet from the tunnel mouth. About 50 feet of talcose slate occurs bordering the talc body proper, which has a width of 5 to 8 feet. This talcose slate is of the nature of soapstone, but appears to be badly flawed, and checks readily. The talc band consists of very loose rock, and would be difficult to work underground on account of creeps.

The talc band is exposed also at a point east of the tunnel, in the side of the gorge cut down through the slates by the Nahatlatch river. It is also reported to outcrop on the hillside above the tunnel.

The talc ranges in colour from rather light to dark olive green, and is translucent in thin pieces. The only visible mineral impurity is quartz, in occasional thin impersistent layers. The talc grinds to a soft powder, showing no evidence of grit.

The deposit is well situated for shipping, lying only a few hundred feet from the railway and well above the level of the track. The freight rate to Vancouver is $2.60 per ton (October, 1920). There is no mining equipment of any kind on the property.

While relatively narrow, the deposit could probably yield a moderate tonnage of grinding talc of fair quality. The material appears to be too badly flawed to be suitable for lava purposes or for cutting into blocks.

An analysis of the talc of this deposit, made by J. R. Williams, provincial assayer, Vancouver, and furnished the writer by the B.C. Silica and Talc Company, showed:—

Silica	63·00
Magnesia	30·65
Alumina	3·02
Ferrous oxide	0·92
Combined alkalies	0·39
Water	2·00
	99·98

A sample taken by the writer from the main talc band in the tunnel, and analysed in the Mines Branch laboratory, yielded:—

Silica	59·88
Ferrous oxide	4·54
Ferric oxide	none
Alumina	1·18
Lime	0·10
Magnesia	29·51
Carbon dioxide	0·02
Water above 105° C	4·73
	99·96

The analysis shows the material to be clean talc of good grade.

Lillooet Mining Division

Talc has been worked at Mile 92, one-fourth of a mile south of the mouth of McGillivray creek, near D'Arcy, on the Pacific Great Eastern railway. Up to the present, work has been confined to one claim, the Lucky Jane, but talc of similar grade is reported from several places in the vicinity.

According to information furnished by the operators, the Pacific Roofing Company, Granville island, Vancouver, B.C., the deposit was worked for several months in 1919. About 150 tons of talc were mined and shipped to the company's roofing plant in Vancouver, where it is ground in a Forrester rod mill and screened through 40 mesh, for use in surfacing roofing paper. The ore-body consists of a lens of schistose talc, 8 feet wide and nearly vertical, enclosed in slate. It has been worked by means of a 50-foot tunnel, located close to the railway track, the talc being loaded directly into cars.

The talc is grey-green in colour, mottled with darker green. Under the microscope, small, flattened particles of bornite are visible. It grinds to a soft, nearly white powder, with little evidence of grit. The talc exhibits a fissile structure, with evidence of crumpling, and breaks up readily into relatively thin layers. While hitherto utilized only for roofing purposes, the material would yield a fair grade of off-colour ground talc for the paper, rubber, and paint trades.

An analysis of a representative sample of this talc, made in the Mines Branch laboratory, showed:—

Silica	57·62
Ferrous oxide	5·31
Ferric oxide	0·80
Alumina	2·46
Lime	0·10
Magnesia	28·53
Carbon dioxide	none
Water above 105° C.	4·75
	99·57

The analysis shows that the material is reasonably pure talc, there being no free silica (quartz) or carbonate present.

C. Camsell makes[1] the following reference to the talcose rocks of this region:—

Both the Carboniferous and Triassic rocks in the Coast Mountains contain bands of talcose rocks associated with the other beds. Samples of a high grade commercial talc have been found in the stream deposits of Cayuse creek, which come no doubt from the Carboniferous rocks higher up on that stream. About two carloads of talc have been shipped from a bed about 3 feet wide that crosses the railway track at Anderson lake, near the mouth of McGillivray creek. Talc occurs again in the form of talc schist just west of Owl creek, but an examination of this by Mr. Keele, of the Mines Branch, shows that the material is too gritty and dark coloured to be useful in the paper industry, and the rock itself is too impure to be of value as a commercial source of talc.

Victoria Mining Division (Vancouver Island)

Talc is found on the Eagle claim, on Wolf creek, a tributary of Leech river, about three-fourths of a mile from the confluence of the two streams and a like distance from the track of the Canadian National railway. The distance from Victoria is 33 miles. The owner and operator is W. G. Dickinson, 576 Dallas road, Victoria, who has worked intermittently since 1919. When the property was visited in October, 1920, a loading spur had been installed at Mile 33, the ore being hauled by motor truck from the mine. The owner reported shipments of 300 tons up to that time, the destination being the owner's mill at Sidney, V.I.

[1] Geol. Surv. Can., Summary Report, 1917, p. 22B.

The deposit is a narrow band of greyish-green talc schist, dipping north at an angle of about 60°. It is bordered on the foot-wall by dark green, crumpled, chloritic slate, and on the hanging-wall by grey clay slate. The talc body is exposed in the west bank of Wolf creek, which is there 25 feet high. A tunnel

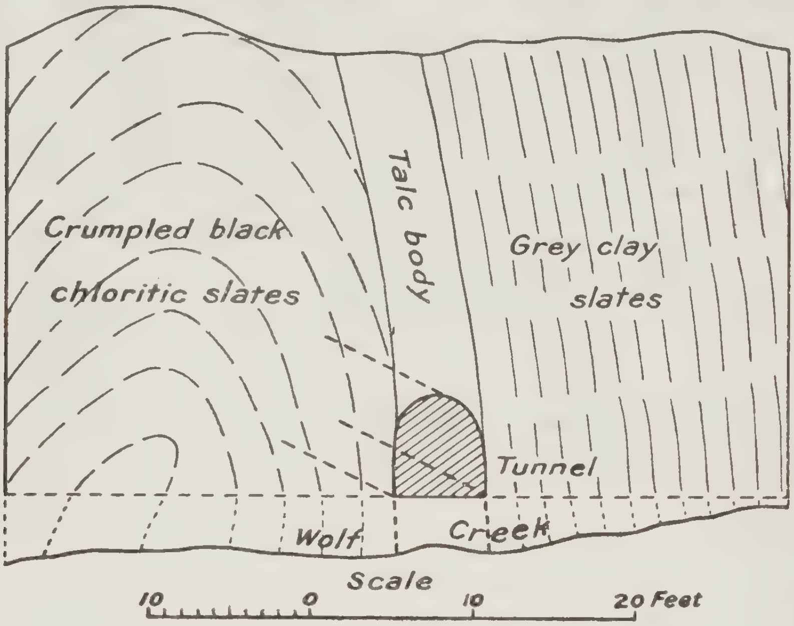

Fig. 1. Sketch showing section through talc body on Wolf creek, Victoria mining division, Vancouver island, B.C.

has been driven 50 feet into the bank, following the strike of the deposit. When the property was visited in October, 1920, a slip had temporarily closed the tunnel, and little of the talc body was visible. The owner reports a width of 18 feet of talc in the drift.

An improvised gasoline hoist, used to raise the ore from the creek level to the loading platform, was the only mining appliance on the property.

The talc body evidently represents an altered band of coarse-grained dolomite, and has an approximately schistose structure. Analysis shows that the rock is relatively low in silica and contains much lime and carbon dioxide; it effervesces freely with acid. Small amounts of a sulphide (probably iron pyrites) and magnetite are visible under the microscope. An analysis of a typical sample of the talc rock, made in the Mines Branch laboratory, gave the following:—

Silica	33·68
Ferrous oxide	4·97
Ferric oxide	none
Alumina	1·65
Lime	15·32
Magnesia	22·88
Carbon dioxide	18·23
Water above 105° C.	3·20
	99·93

From the above analysis, the approximate composition of the rock may be determined as:—

Kaolin	4 per cent
Talc	50 "
Dolomite } Calcite }	38 "

The material is light greyish-green in colour and grinds to a light grey powder, which is reported to have been pronounced by Pacific Coast paper mills as suitable for use in various grades of paper. Contracts are stated to have been signed with Washington paper mills for supplies of the crude talc.

The grinding mill at Sidney has up to the present produced ground talc for roofing purposes only, and is an experimental plant.[1] It contains one Jeffrey swing hammer pulverizer, and one vertical burr mill. The fines are drawn from both pulverizer and burr mill by suction into a dust chamber, making both a coarse and a fine product. No dryer is used.

NOVA SCOTIA

Inverness County, Cape Breton Island

A number of years ago a small deposit of talc was worked by R. P. Fraser, of Pictou, at Fraser's mill, near Whycocomagh. Only traces of the old workings remain, and they were not at all extensive. A small amount of talc is reported to have been shipped to Pictou for grinding.

The locality was visited by the writer in 1919, and as far as could be seen, the deposit appears to consist of narrow bands of massive, cream-coloured talc, separated by grey quartzite, in a dolomite country rock. According to Fletcher's map,[2] the rocks are of Upper Pre-Cambrian age. The apparent dip of the beds is about 45° north, into the hill on the north side of Brigend brook. None of the talc bands seen exceeded 12 inches in width, and the waste dumps around the old workings contain only quite small pieces of talc. The material yields an almost white powder, and contains little in the way of other mineral impurities. The narrowness of the talc bands, however, indicates that the deposit can hardly possess economic importance.

A small sample of picked talc, collected from the waste dumps, and analysed in the Mines Branch laboratory, proved to contain:—

Silica	58·88
Ferrous oxide	0·46
Ferric oxide	0·04
Alumina	0·81
Lime	1·80
Magnesia	31·74
Carbon dioxide	1·32
Water above 105° C	5·00
	100·05

These figures show that the clean material of the deposit contains over 90 per cent of pure talc.

Southeast Cape Breton Island

Talc has been recorded from several localities along the southeast coast of Cape Breton island, chiefly in Cape Breton county. These localities include: Eagle head, Kennington cove, and Landing cove, all in the vicinity of Gabarus

[1] This mill was destroyed by fire during 1921, and a new mill is understood to have been erected at the mine.

[2] Geol. Surv. Can., Sheet 15, Province of Nova Scotia, 1884.

bay. Specimens of talc from various places in this district are exhibited in the museum of the Technical College, in Halifax. In general, they all appear to be similar to the pale, creamy material from Whycocomagh. Fletcher mentions[1] the occurrence of steatite in thin layers in the felsite and quartzite of Eagle head.

A. O. Hayes has described[2] an occurrence of sericite from Landing cove, 4 miles west of Louisburg, and it appears probable that much of the so-called talc of this section is in reality sericite, or a mixture of sericite and talc. According to Hayes, the sericite occurs in close association with stratified volcanic rocks, and is in the form of sericite schist, the whole series being tilted to a vertical position. Two shafts were sunk on the sericite schist outcrops about the year 1898, and short drifts were run along the deposits. The sericite mined was shipped to the United States.

Aside from the above-mentioned work, no mining for talc has been done in this district, and the occurrences do not appear to be of commercial importance.

ONTARIO

Frontenac County

TOWNSHIP OF PITTSBURGH

Concession III, lot 35, S. ½. Dark, soft rock, that appears to be a partly altered pyroxenite, occurs on this lot and was worked about the year 1900 by the Sparham Roofing Company, of Montreal, who used the material in the manufacture of fireproof roofing. There are a few small scattered pits on the property, which lies 5 miles west of Gananoque, about one-fourth of a mile south of the Gananoque-Kingston road. A few hundred tons of material are reported to have been shipped. From its general appearance the rock probably consists largely of pyrallolite, which is pyroxene in various stages of alteration to steatite, or massive talc.

An analysis of the soft rock that occurs in several of the pits was made in the Mines Branch laboratory, and showed:—

Silica	50·64
Ferrous oxide	0·79
Ferric oxide	0·55
Alumina	1·06
Lime	4·84
Magnesia	30·49
Carbon dioxide	5·21
Water above 105° C.	6·26
	99·84

The silica content is too low to class the rock with talc, and it is probably mainly composed of mineral substance more closely allied to one of the serpentine group of minerals. The rock grinds to a grey powder possessing fair slip.

[2] Geol. Surv. Can., Summary Report, 1918, Part F, pp. 18-20.
[1] Geol. Surv. Can., Rep. Prog., 1877-8, p. 30F.

According to the Ontario Bureau of Mines Annual Report, XI, 1901, p. 297, 1,800 tons of serpentine rock were quarried from a locality two miles west of Gananoque, in Leeds township, during the five years 1896-1901. This material was taken out by Geo. Jackson, and was shipped to Montreal for roofing purposes.

Hastings County

TOWNSHIP OF GRIMSTHORPE

Concession V, lots 8, 9, and 10. A very pure, foliated talc of a green colour is found on these lots. The material occurs in narrow veins, carrying aggregates of large leaves (crystals) of talc, and closely resembles that found on lot 2, Craig's Road range, township of Ireland, in Megantic county, Quebec. An analysis of this talc yielded[1] :—

Silica	60·45
Alumina	0·27
Iron oxide	2·82
Lime	0·16
Magnesia	29·84
Water	5·74
Nickel oxide	0·50

No work has been done on this deposit, which is of mineralogical rather than economic interest.

TOWNSHIP OF HUNTINGDON

Concession XIV, lot 14. Henderson mine. This was the first mine opened for talc in the Madoc district, the initial work on the property having been done in 1899. In that year a small shipment of crude talc was made to the United States, the material being reported as used for talcum powder. Development of the property proceeded slowly until 1906, when the first talc mill in the district was erected at Madoc station, to grind the ore from this mine. Mine and mill were, however, under separate management, the former being operated by S. Wellington, and the latter by Geo. H. Gillespie and Company. After the erection of the Gillespie mill, the output of the mine increased considerably, reaching a maximum of over 12,000 tons in 1917. Most of this talc has been milled at Madoc, but a few thousand tons has also been shipped in the crude state to United States consumers. The total output to date of crude talc from this property is in the neighbourhood of 120,000 tons, and the mine constitutes one of the world's important producers of superfine, white foliated talc.

The mine (Plate I) lies about 1½ mile southeast of Madoc station, the terminus of a branch line of the Grand Trunk railway, connecting with the main line at Belleville. The ore is teamed from the mine to Madoc. Operated for a number of years by S. Wellington, and later by Cross and Wellington, of Madoc, the mine was taken over in 1918 by Henderson Talc Mines, Ltd., who are the present operators.

The mine was first worked open cast, drifts being later run from the bottom of the pit along the strike of the talc body. In 1906 a shaft was sunk 100 feet on the deposit to the southwest of the open pit, and this was deepened in succeeding years to 225 feet, levels being run at 75 feet, 120 feet, and 185 feet.

[1] Geol. Surv. Can., Vol. VI, 1892-3, p. 18R.

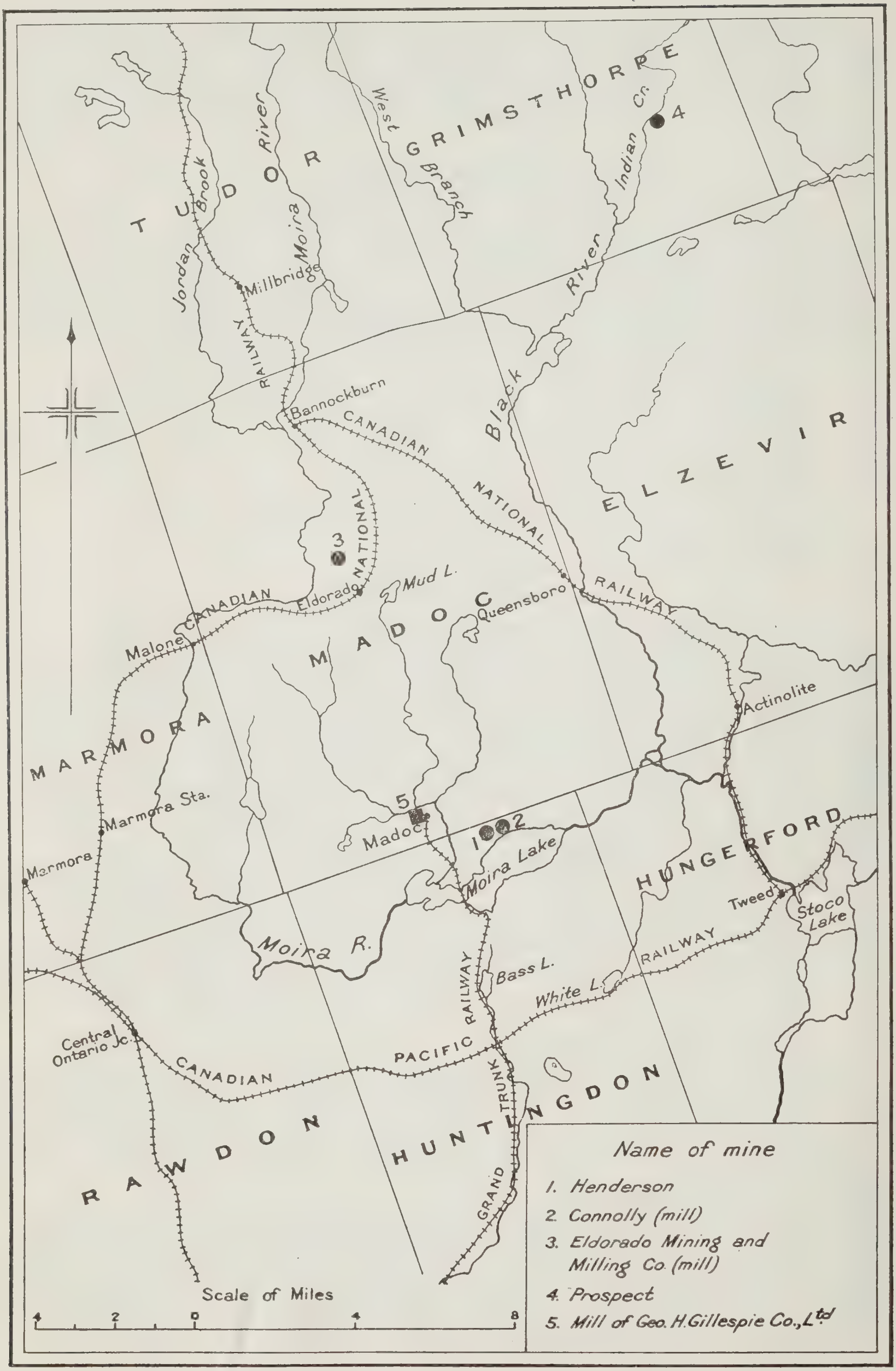

Fig. 2. Map showing location of talc mines and mills in Madoc district, Hastings county, Ontario.

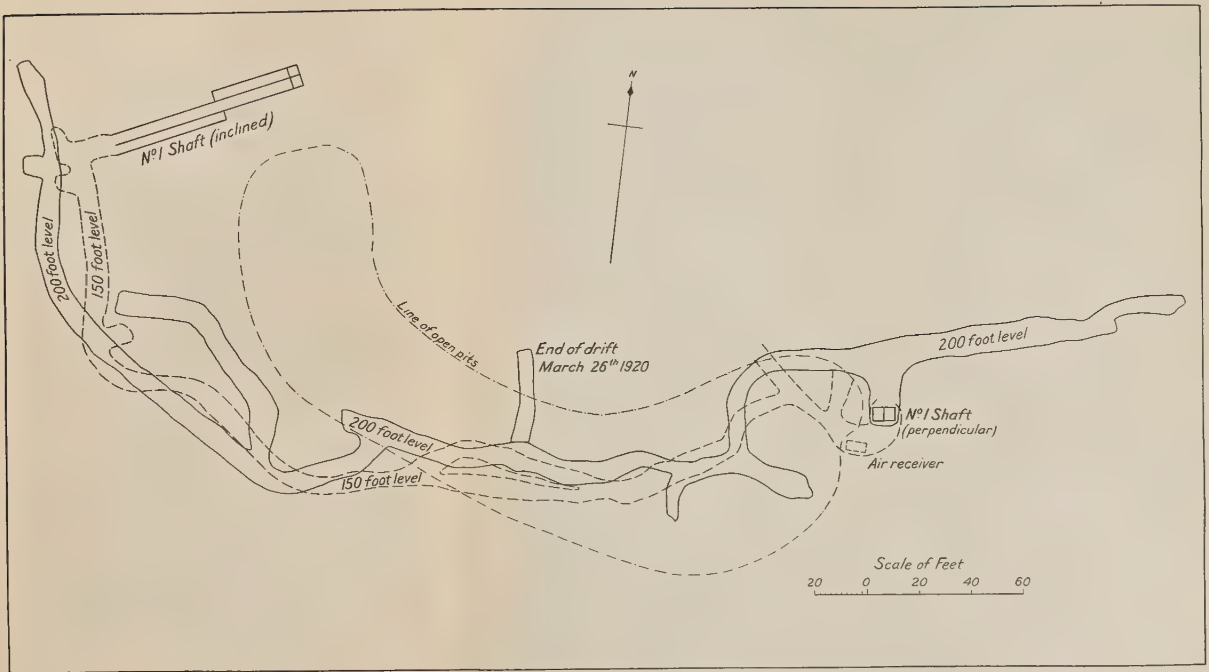

Fig. 3. Plan of mine workings at Henderson talc mine, lot 14, concession XIV, township of Madoc, Ont., (March, 1920).

Owing to caving of the workings in 1913, this shaft was abandoned, and work proceeded from a second shaft, levels being run to the old workings. In 1919 this shaft had been carried down 230 feet, with about 500 feet of drifting on the 150-foot and 200-foot levels.

C. W. Knight[1] describes the deposit as follows:—

The deposit occurs in a brown, somewhat quartzose, crystalline limestone of Grenville age, an analysis of which shows it to have the following composition:—

Lime	29·29 per cent
Magnesia	15·53 "
Carbon dioxide	43·67 "
Insoluble	4·62 "

The talc has a width which varies from 25 feet, or less, to 40 feet. The crystalline limestone on each side of the deposit contains bands of white quartz several feet or more wide. A horizontal plan shows the talc to occur in the form of a horseshoe, or the letter V, due to the strata having been sharply folded. The extent of the body has not yet been determined in the underground workings, and the surface on each side of the hill is covered witth drift.

It is probable that the talc has resulted from the alteration of the crystalline limestone, since many parts of the occurrence still show distinct traces of the original bedding or lamination of the limestone. The origin of the talc may be partly connected with the intrusion of the Moira granite, from which circulated silica-holding waters. The latter probably acted on the dolomitic limestone, giving rise to the hydrated magnesian silicate talc.

A plan of the mine workings is shown in Fig. 3.

From Miller and Knight's geological map of the area, accompanying the Guide Book referred to in the footnote, the mine workings would appear to be situated at or near the crest of a pitching anticline, the limbs of which strike northwest and northeast. The Connolly talc mine (operated formerly by the Anglo-American Talc Corporation and now by the Asbestos Pulp Company, Ltd.) on the adjoining lot to the east, is situated on a continuation of the northeast limb. The two sets of workings are only a few hundred yards apart. The old open cut workings have the form of a flattened U, lying approximately east and west, and extend a total distance of about 300 feet. In the underground workings the talc body has been stoped out in the same general form, but no limit to the extent of the deposit in depth has been found. A maximum width of 75 feet of ore has been encountered in the lower workings.

The talc is uniformly of the same general character throughout the deposit, being of a light cream colour, and medium to coarsely foliated. The ore consists of a mass of shapeless folia, which are usually elongated in the same direction, thus imparting to the rock a schistoid character. Massive talc, or steatite, does not occur in any quantity, but a small amount of a light-coloured compact, impure steatite was noticed on the waste dump of the Connolly mine. Quartz, dolomite and magnesite, in the form of grains and stringers, are the principal impurities in the ore, and the talc grades into dolomitic limestone at the borders of the lenses. The deposit shows evidence of considerable squeezing, and is traversed by numerous slip faces. The dip of the deposit is approximately vertical.

The mine, and the Gillespie mill at Madoc station, are supplied with electric power from the Seymour Power and Electric Company.

[1] Guide Book No. 6. International Geological Congress, 1913, p. 58.

Mill

The mill of George H. Gillespie Company, Ltd. (Plate II), runs entirely on ore from the Henderson mine. The mine and mill are, however, operated by different companies.

This mill was the first in Canada to undertake the fine grinding of talc on a large scale and the production of various grades of superfine talc for the market. Previous to its establishment, practically all of the talc mined and ground in Canada was impure talc and soapstone, which was used almost solely as roofing material.

The first mill installation was on experimental lines, much of the machinery being similar to that used in flour grinding. From an original capacity of 8 tons per 24 hours the mill has risen to 50 tons. The mill system has been modified and extended from time to time, but the same general methods have been adhered to for a number of years past and have proved highly efficient. A conspicuous feature of the system used is that bolting of the fines through silk cloth is still practised, although the general tendency in modern talc milling has been to replace bolting by air separation, the latter method being regarded as more economical and efficient.

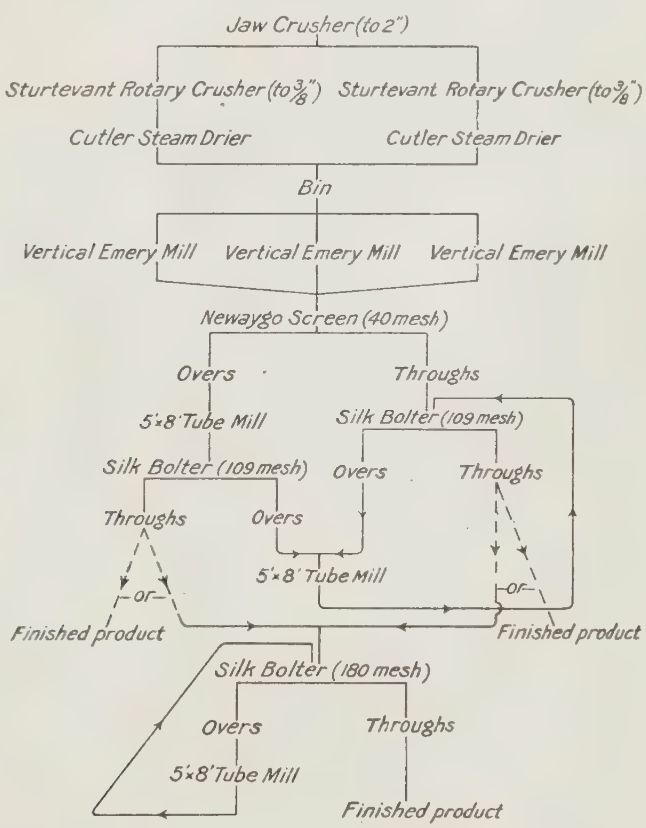

Fig. 4. Outline of mill system at talc mill of Geo. H. Gillespie Company, Ltd., Madoc, Ont.

R. B. Ladoo, of the United States Bureau of Mines, who has made a study of talc mining and milling in the United States, has described[1] the method of milling as practised at this mill in a recent publication of the Bureau, and the

[1] U.S. Bureau of Mines, Reports of Investigations, September, 1920.

following remarks, as well as the accompanying flow sheet of the mill, are taken from his report:—

Ore from the mine is dumped into a small bin from which it is drawn off and fed by hand into the crusher. The progress of the ore through the mill is indicated approximately on the accompanying flow sheet. No attempt has been made to show elevator or conveyor, as the present system of transportation is complicated by lack of concentration of similar machines. The type of dryers used is unusual in talc mills. They are of the Cutler type, made by the Nordyke-Marmon Company, for use originally as corn dryers. Essentially they consist of a bundle of steam heated pipes, set in circular headers, which are revolved mechanically about an axis nearly horizontal. The talc enters at one end and is cascaded around and between the hot pipes until it reaches the other end. The drying temperature may be regulated very closely, thus guarding against overheating, and there is no soot or ashes to contaminate the product. It has been found advisable to convey the dried talc for some distance in the open air before being fed to the next machine. This allows the moisture which has been driven out from the pores of the rock to evaporate.

The opinion has often been expressed in the United States that the bolting of talc through silk cloth was obsolete, due to slowness and excessive cost. This will demonstrate that bolting can be done efficiently and economically, if proper precautions are taken. The secrets of success here seem to be: (1) careful sizing of the talc before bolting; (2) the utilization of a large number of bolts; (3) no overloading of bolts; (4) intelligent and careful supervision. Another feature of this mill is the use of short 5′ x 8′ continuous feed and discharge tube mills, instead of the intermittent dump cylinders or the long 6′ x 24′ continuous tube mills used in other parts of the country. Furthermore, the tube mills here are used simply in closed circuit with bolts, instead of three or four in tandem. This close and careful sizing not only produces a very uniform product but cuts down greatly the power consumption for grinding.

Three grades of ground talc are ordinarily made here, based on colour and grain size. The most important consumers are the toilet powder, textile and soap industries. The present mill capacity is about 50 tons per 22-hour day, for the production of which about 140 horsepower is used. The erection of a new mill of 100-ton capacity, but following the present system of milling, is contemplated.

The following analyses were made in the Mines Branch laboratory of a sample of crude ore from the Henderson mine, and on samples of the three grades of ground talc produced at the mill of Geo. H. Gillespie Company, Ltd.:—

—	1	2	3	4
Silica	53·92	51·00	49·48	49·28
Ferrous oxide	0·36	0·32	0·24	0·19
Ferric oxide	none	0·13	0·13	0·14
Alumina	0·32	0·62	0·82	0·41
Lime	5·02	6·98	7·02	7·06
Magnesia	29·63	28·76	29·11	29·21
Carbon dioxide	5·51	7·72	9·02	9·26
Water above 105° C	5·05	4·70	4·13	4·55
	99·81	100·23	99·95	100·10

1. Crude ore from Henderson mine, Madoc.
2. No. 1 (talcum, surfaced paper) grade, ground talc.
3. No. 2 (textile, paper filler) grade, ground talc.
4. No. 3 (soap, rubber) grade, ground talc.

The three mill products were analysed in order to ascertain whether the milling process effected any material separation of the mineral constituents of the different grades, with segregation of the silica and dolomite into particular products. The analyses show a rise in the content of carbon dioxide

from the No. 1 to the No. 3 mill product. Calculated on the basis of a theoretical 1:1 lime-magnesia dolomite, these figures show the following percentages of dolomite in the three products:—

No. 1 grade—16·1 per cent dolomite.
No. 2 grade—18·8 " "
No. 3 grade—19·4 " "

There is, then, an average of 3 per cent less dolomite in the No. 1 (fine) mill product than in the other two grades. It would, however, need a series of analyses, run on periodic samples, to determine conclusively whether the above results are effected by thé milling process, or are fortuitous.

No relation is to be looked for between the analyses of the crude ore and the mill products, since the sample of ore was taken at the mine and was selected as characteristic of the best grade of ore produced.

Concession XIV, lot 15. Connolly mine. This property lies on the adjoining lot east of the Henderson mine, the two sets of workings being only a few hundred yards apart. The initial work was commenced in 1912, in which year a 70-foot shaft was sunk, with 75 feet of drifting at that level. This work proved up a vertical body of talc, which is evidently an extension to the northeast of the same deposit opened up in the Henderson mine, and in 1915 the property was taken over by the Anglo-American Talc Corporation, Ltd. This concern continued development work, and in 1916 erected a mill on the property. When visited in 1919, there was a total depth of shaft of 200 feet, with about 300 feet of drift to the northeast and 100 feet to the southwest on each of the three levels. The levels are run at 65 feet, 125 feet, and 185 feet, respectively, and the ore is extracted by stoping.

Since the erection of the mill, most of the ore mined has been ground on the spot, but a small amount of crude talc has also been shipped to the United

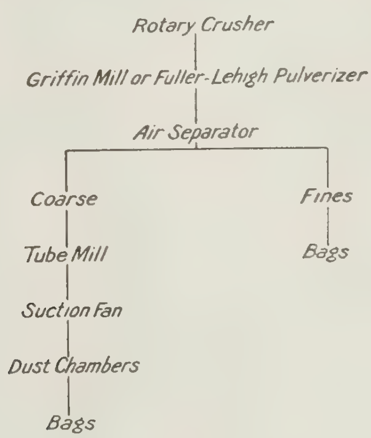

Fig. 5. Flow sheet of mill system at mill of Anglo-American Talc Corporation, Madoc, Ont.

States. In 1921 the property was taken over by the Asbestos Pulp Company, Ltd.

The average width of the talc body in the underground workings is stated to be about 12 feet, and the material is similar in its general character to that found on the adjoining Henderson property. The bulk of the output is used in the paper industry. A little massive, impure steatite occurs in a band

bordering the talc body proper. This material has a greenish-grey colour, is quite compact and without grain, but lacks the greasy feel of good talc. Cubes of this material fired at 1000°C. became creamy-brown in colour and very hard, but developed slight checks. It is questionable whether the substance would prove suitable for lava purposes.

Mill

The mill on this property has a rated capacity of about 30 tons of ground talc per 24 hours. The ore is first crushed in a rotary crusher and is then fed to a Griffin mill, or to a Fuller-Lehigh pulverizer mill. No dryer is used. The product of the above passes to a revolving drum fitted with an air separator, the fines going direct to bags. The heavies are fed to a pebble mill, also equipped with an air separator, which delivers to dust chambers. Four products are made.

Concession XIV, lot 16. This lot was prospected in 1917 by the International Pulp Company, of Gouverneur, N.Y., who drilled the property and sank an inclined shaft 50 feet, with 100 feet of cross-cut at this depth. A second 80-foot, vertical shaft was put down in 1918 about one-fourth of a mile west of No. 1 shaft, with 70 feet of cross-cutting. No suitable ore was encountered and operations were abandoned.

TOWNSHIP OF MADOC

Concession V, lot 20. Mining for talc was undertaken on this lot in 1911 by the Canadian Talc and Silica Company, who sunk a 75-foot shaft and erected a mill on the property. Work was continued until 1915, the shaft being deepened to 90 feet and a second shaft sunk to 130 feet. A 200-foot drift was run from the bottom of No. 1 shaft to meet No. 2 shaft. In 1914 the company was reorganized under the name Eldorite, Ltd., but only worked to the end of 1915. The property was idle till the end of 1918, when it was taken over by the Eldorado Mining and Milling Company, Ltd., of Chicago, the present operators.

When visited in 1919, the workings comprised No. 1 and No. 2 shafts, respectively 125 feet and 175 feet deep. No. 1 shaft lies northeast of No 2, and from it a drift of 200 feet has been carried to No. 2 on the 75-foot level. About 100 feet of drift has been run from No. 2 shaft on the 140-foot level. No. 1 shaft is inclined 75° and No. 2 about 55°.

The property lies about 2 miles from Eldorado station, on the Trenton-Maynooth branch of the Canadian National railway. It is the only talc mine in the Eldorado area, and lies 8 miles north of the Madoc deposit.

The talc body strikes in a northwesterly direction and dips about 50° NE. The general run of the ore is not as clean talc as that of the Madoc deposit, there being a considerable admixture of quartz and dolomite or magnesite, in the form of included grains or crystals or as thin stringers. The width of the talc zone is reported to be over 100 feet in the underground workings, and outcrops indicate the existence of talc over a width of between 400 and 500 feet. It is possible, however, that this apparent width of ore-body is due to folding. Along the strike, the deposit is reported to have been traced for over a mile.

The workings lie close to the east bank of the Moira river, which at this point follows the contact of the talc body with granite. The predominant country rock is granitic, locally overlain by Palæozoic limestone. A short distance to the east of the main workings, a deposit of crumpled, dark grey talc schist occurs. In 1919 plans were made to work this material, and a small, separate mill was erected to grind it for the rubber and foundry facings trades.

Electric power for the mine and mill is obtained from the Seymour Power and Electric Company, but in 1919 a dam was erected on the Moira river to furnish the company with its own power. One small boiler is used to heat the dryer in the mill.

Mill

The mill is a 3-story structure, and the mill practice is similar to that followed in other mills in the district. The ore is first crushed in a rotary

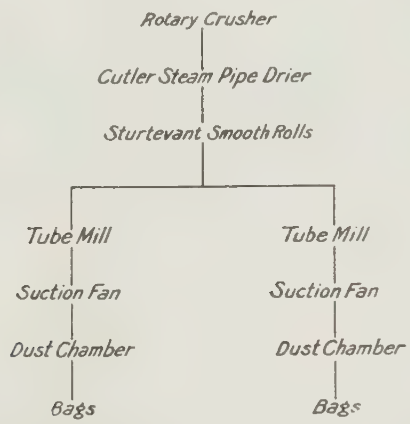

Fig. 6. Flow sheet of mill system at mill of Eldorado Mining and Milling Company, Eldorado, Ont.

crusher, passes to a rotary steam-pipe dryer, and is then fed to Sturtevant smooth rolls. The earlier practice was to grind the product from the rolls in vertical emery burr mills, but the latter were replaced in 1918 by two pebble mills. These mills are connected with air separators, which draw out the fines as soon as made and deliver them to dust chambers. Four grades of talc are made, the three finest being designed for the paper trade and for paint manufacture, while the fourth grade is used for roofing purposes. The small, separate mill erected in 1919 treats only the grey talc schist referred to above and is equipped with a tube mill and air flotation.

Lanark County

TOWNSHIP OF LAVANT

Concession III, lot 24, E. ½. Diamond drilling on a talc body on this lot was done several years ago by the owner, T. B. Caldwell, of Perth, Ont. One 120-foot drill hole was put down, and a few shallow prospect pits were opened.

The property lies two miles south of Flower station, on the Kingston and Pembroke branch of the Canadian Pacific railway, but is actually distant only one-fourth of a mile from another point on the railway, with which, however, there is no road connection.

The deposit consists of a low, denuded hogsback, about 50 feet wide, and extending 300 feet in a northeast direction. Several small prospect pits have been opened at the base on the west side. The apparent dip is 20° east.

The material of the ridge, as exposed on the surface and in the pits, is a fine-grained, white, siliceous, serpentinised dolomite, representing a band of altered, high-magnesia limestone in the Pre-Cambrian gneiss-limestone complex. The silica is prominent on weathered surfaces as small nodules or stringers of quartz, that form possibly 5 per cent of the mass. The rock effervesces freely with acid, showing that considerable calcite is present. The magnesium silicate present would appear to be more of the nature of serpentine than talc, as very little talc can be detected under the microscope, and there is not sufficient present to impart more than a slight slip to the powder, which is distinctly gritty.

The following are analyses of the material of this deposit. No. 1 was made in the Mines Branch laboratory on a representative sample collected from the various pits and outcrops; No. 2 was made at the School of Mines, Kingston, Ont., and was furnished by the owner:—

—	1	2
Silica	52·50	57·70
Ferrous oxide	0·28	....
Ferric oxide	0·10	1·10
Alumina	0·17	....
Lime	9·26	4·96
Magnesia	26·04	26·78
Carbon dioxide	6·85	1·90
Water above 105° C	5·13	7·21
	100·33	99·65

Leeds County

RIDEAU LAKE

Grindstone island. This island lies two miles northwest of Portland village, on the Ottawa-Toronto line of the Canadian National railway. The present owner is understood to be Lady Kingsmill, of Ottawa.

Between the years 1893 and 1899 a quantity of rock was quarried on this island and shipped by scow to Montreal, via the Rideau canal, to be used in the manufacture of roofing. The operators were the Sparham Roofing Company, of Montreal. The stone was shipped in the crude state, and was ground in Montreal. No work has been done since 1899.

The workings consist of a single, almost circular, pit, opened in the east face of the low bluff fronting the lake. This pit measures 75 feet across, and has been carried down nearly to lake level, with a depth of about 25 feet.

The material of the deposit is a soft, brown to grey-green, altered pyroxenite. The rock is, variously, medium to coarse-grained, and varies somewhat widely in the degree of alteration it has undergone. In some parts of the

quarry, fairly fresh, unaltered pyroxenite predominates. Pink calcite occurs locally in considerable amount. The rock has all the appearance of a typical mica-bearing pyroxenite, that has undergone pronounced, local metamorphism by solutions from a later pegmatitic intrusion, with complete or partial alteration of the pyroxenite to rensselærite or pyrallolite. No pegmatite was observed in the pit.

A sample of the stone from the stock pile near the old loading wharf, ground to pass 100 mesh, yielded a dirty, grey-white powder, having little or no slip. An analysis of this material, made in the Mines Branch laboratory, showed:—

Silica	54·62
Ferrous oxide	1·41
Ferric oxide	0·88
Alumina	0·09
Lime	4·90
Magnesia	28·56
Carbon dioxide	4·59
Water above 105° C	5·01
	100·06

Sudbury District

TOWNSHIP OF MAY

In the Annual Report of the Ontario Bureau of Mines, 1896, p. 278, reference is made to an occurrence of talc in "the southeast corner of May township, Algoma district, 10 miles by wagon road from the railway." According to the above report, a 40-foot shaft was sunk on the deposit, in 1896, by the Spanish River Nickel Mining Company. The talc body is described as having a width of 2½ feet at the surface, widening to 11 feet at 40 feet. Apparently no further work has been done on the property.

Kenora District

LAKE OF THE WOODS

An attempt was made some years ago to obtain from a deposit near Kenora, soapstone suitable for lining the smelting furnaces of sulphate pulp mills. The location of the deposit is on the portage between Moore and Andrew bays, Lake of the Woods, 12 miles southeast of Kenora. The last claim number filed was K722, but the claim has now lapsed. The only operators have been the Dryden Pulp and Paper Company, Dryden, Ont., who carried out the work referred to above, and who are reported to have shipped four carloads of stone to their Dryden mill. This stone was sawn into blocks and tested as furnace-lining material, but the company reports that it proved too seamy for the purpose and did not stand up under the heat.

The stone cannot be classed as a soapstone, and possesses more the character of a soft, chloritic slate. It is brownish-green in colour, somewhat harsh to the touch, and yields a dirty grey powder having little or no slip. It occurs as a band about 75 feet wide, enclosed in harder, grey slate, and striking almost due east. The dip is steep. The rock has a slaty structure, exhibits consider-

able jointing, and breaks out in large blocks; it stands up well under the hammer. The band is drift-covered east of the outcrop on Moore bay, and its extent was not determined. It has been quarried in the face of the low bluff fronting on Moore bay, at the point where the 100-foot Pipestone portage crosses to Andrew bay. The material taken out was shipped by scow to the railway at Kenora.

An analysis of a typical sample of the rock from this occurrence was made in the Mines Branch laboratory and showed:—

Silica	39·14
Ferrous oxide	8·79
Ferric oxide	3·48
Alumina	7·32
Lime	5·92
Magnesia	21·31
Carbon dioxide	7·31
Water above 105° C	6·68
	99·95

The analysis indicates that the rock is composed of a variety of minerals, and contains considerable dolomite or ankerite; the principal component is probably chlorite.

TOWNSHIP OF ZEALAND, WABIGOON LAKE

Mining Location HW133. Owned by E. G. Pidgeon, Wabigoon, Ont. An interesting and extensive deposit of so-called soapstone occurs here. The locality was visited in October, 1921, and the following notes on the occurrence were made, but the small amount of development work done on the property precluded full details being secured.

The rock of this deposit may be termed soapstone for want of a better name, though it possesses few of the outward characteristics of normal soapstone. It more nearly resembles the Alberene stone, mined in Virginia, and utilized extensively for many of the purposes usually served by soapstone. Analysis of the two stones shows that they correspond very closely in mineral composition.

The Wabigoon stone is a dark greenish-grey rock, composed largely of talc, with some chlorite and dolomite. It is soft enough to be scratched with the finger nail. The rock is fine to medium-grained, the largest constituents being dolomite crystals that occur as phenocrysts up to ⅛-inch diameter. There is no approach to schistose structure, the grain being quite uniform and the rock massive and homogeneous. The stone yields a greenish-grey powder. This, screened through 100 mesh, possesses fair slip but is distinctly gritty.

Two well-defined bands of soapstone occur, separated by about 100 feet of hard, greenish rock, resembling an altered diorite. The trend of these bands is northwest, and the dip approximately vertical. The soapstone is well exposed on the summit and west slope of a low ridge that crosses a small peninsula extending from the north shore of the lake, about one mile west of Wabigoon station, on the main line of the Canadian Pacific railway. The actual distance from the track is only 500 yards, and the intervening ground is level and well adapted to the laying of a spur.

The northern band has a proved length of over 500 feet, with an average width of 35 feet. The extent of the southern band has not been determined, but, judging from the visible outcrops, it is probably considerably larger. There is little overburden on the deposit, and only a light stand of second growth trees.

The northern band has been stripped for a short distance, but no openings have been made on it. No work has been done on the southern band.

The northern band consists of about 35 feet of medium-grained stone, apparently homogeneous throughout its width. Bordering this, along each contact, is about 18 inches of fine-grained, compact, soft soapstone. This soapstone is of very good quality, but its occurrence appears to be confined to the narrow band along the contacts, and there is relatively little of it.

Small veinlets and pockety aggregates of green, foliated talc occur locally in the mass of the main soapstone bodies, but such material does not appear to be present in any quantity.

The deposit is well situated for working, the exposures being on the top of a ridge, thus providing good drainage for quarry operations. The proximity to rail, also, is an important factor.

The following analyses of samples of the stone of the northern body, and of that of the 18-inch band of soft soapstone bordering this deposit, were made in the Mines Branch laboratory. An analysis of a sample of Virginia Alberene stone, such as is used for lining the smelting furnaces of sulphate pulp mills, is shown for comparison. The analyses show that the Wabigoon stone contains considerably less carbonates than the Alberene stone.

—	1	2	3
Silica	41·94	51·44	37·10
Ferrous oxide	7·71	7·24	6·58
Ferric oxide	2·05	3·68	4·57
Alumina	7·57	4·79	4·53
Lime	3·42	none	4·20
Magnesia	25·39	26·43	27·37
Carbon dioxide	5·09	0·11	10·45
Water above 105° C	6·71	6·56	5·46
Total	99·88	100·25	100·26

1. Wabigoon stone, representative of material of northern body.
2. Wabigoon stone, 18-inch band of soapstone bordering northern body.
3. Virginia Alberene stone.

In addition, the following tests were conducted in the Mines Branch laboratories on material from the northern body:—

Crushing Strength

Tests were made on three samples, 2-inch cubes being used. The results showed:—

(1) 12,140 pounds per square inch.
(2) 10,269 " " "
(3) 10,755 " " "

Transverse Strength

Tests were made on two samples, the test pieces measuring approximately one inch thick and two inches wide. The supports were four inches apart. These tests gave the modulus of rupture as:—

(1) 1,827 pounds per square inch.
(2) 1,920 " " "

Corrosion Test

A sample of the stone that had been exposed to ordinary room temperature for three months was weighed and then dried for two weeks at 105°C. On re-weighing, there was no loss in weight, indicating no absorbed moisture.

The sample was then immersed in concentrated hydrochloric acid and boiled for 48 hours. After thorough washing, by boiling in water for several days, the sample was dried at 105°C. and weighed. The loss in weight was found to be 9·74 per cent. On immersion in the acid bath, a few small bubbles of gas were given off, indicating the presence of a carbonate. The sample after treatment showed only slight local pitting. A sample of Alberene stone, subjected to the same treatment, effervesced freely when placed in the acid, and exhibited extensive pitting. The loss in weight in this case was 17·95 per cent, or almost twice that of the Wabigoon stone.

Absorption Test

A sample of the stone was dried at 70°C. for 24 hours, weighed and immersed in cold, distilled water for three days. After air-drying for a short time, the sample was weighed, and found to have gained only 0·12 per cent—a negligible amount.

Fusion Test

Two samples were tested for their fusion temperature, which was determined in both cases as 1400°C. A sample of Alberene stone, tested at the same time, went down at 1350°C.

It should be noted that all of the above tests on Wabigoon stone were perforce conducted on material taken from within a few inches of the surface of the deposit. This material, as shown by the broken test pieces, is traversed by numerous flaws and cracks showing rusty surfaces, and is likely to be considerably inferior in all respects to fresh, unweathered stone.

The use that suggests itself most strongly for the stone of this deposit is for bricks for the smelting furnaces of sulphate pulp (kraft) mills. These furnaces require a refractory material that is structurally strong, and that does not spall or crack under the heat to which it is subjected. There are more than a dozen sulphate pulp mills in Canada, and the aggregate amount of soapstone bricks consumed is considerable. All of these bricks are imported from the United States, the principal source being Virginia. If the Wabigoon stone proves suitable, under actual working conditions, for the above purpose, the cost of soapstone to the pulp mills should be materially lessened.

A further suggested use for this stone is for bake oven bricks. Soapstone bricks are superior to ordinary firebricks for bake ovens on account of their greater heat retention, but their use is limited owing to the difficulty of procuring soapstone, and its high cost.

Wabigoon stone might also be suitable for fireless cooker stoves, foot-warmers, etc.

This deposit is the most promising, from an economic standpoint, of the soapstone occurrences examined. There is undoubtedly a large tonnage of stone available; the deposit is within a few hundred yards of the railway, and the location is an excellent one for a quarry site.

Other Localities in Ontario

Talc is also reported to occur at the following localities, but the occurrences do not appear to be of economic importance:—

Addington county, Kaladar township, concession I, lot 5.

Hastings county, Elzevir township.

Frontenac county, Clarendon township, concession II, lot 34.

It is not uncommon in this region to find the pyroxenic rocks, of the same general type as those with which the mica and phosphate bodies are associated, partially altered in the neighbourhood of pegmatic intrusions to impure steatite (pyrallolite or rensselærite). The pegmatite dikes are usually narrow, and, consequently, the degree of alteration of the pyroxene is in most cases correspondingly slight. The grain of the original rock is usually preserved, and the material lacks the unctuous feel of good talc. Logan, in the Geology of Canada, 1863, p. 470, says:—

> Pyrallolite replaces for the most part in the Laurentian system the talcs which are frequent in other series of metamorphic rocks. It differs but little from talc in composition, except in a somewhat greater amount of water, and the two may be regarded as a dimorphous condition of the same silicate of magnesia.

In the Lake of the Woods region, A. C. Lawson mentions—

> Impure serpentines or soapstones in a few localities, most characteristically, however, on the narrows to the south of French portage. The soapstone or pipestone of Pipestone point is simply a soft, decomposed or steatitic variety of the green hornblendic schists, and is not used by the Indians for working their pipes. (Geol. Surv., Can., Ann. Rept., I, 1885, pp. 49CC, 148CC.)

Among the more remote localities at which so-called soapstone has been recorded are the following:—

Robert Bell mentions the occurrence of "massive, grey, semi-crystalline steatitic rock, cut by small veins of whitish bitter spar," near the confluence of the Mattagami and Muskoota-Sagaigan (Flat lake) rivers, northern Ontario. (Geol. Surv. Can., Rep. Prog., 1875-6, p. 312.)

Bell also records that "the Indians at Fort Frances manufacture pipes from a soft, grey slate which occurs on the long point between the mouths of Manitou and Seine rivers," Rainy River district. (Geol. Surv. Can., Rep. Prog., 1873-4, p. 89.)

"Soft grey, uncrystalline slate," used by the Indians as pipe material, is also mentioned by Bell as occurring at Red Point lake, five miles north of the confluence of the Mattawa and English rivers, Keewatin. (Geol. Surv. Can.,

Rep. Prog., 1872-3, p. 103.) This occurrence is also mentioned by D. B. Dowling, who describes the rock as a "soft compact chlorite." (Geol. Surv. Can., Ann. Rep., VII, 1894, p. 13F.)

In his report on the east coast of Hudson bay, R. Bell records that "The Eskimos of the east coast and the islands of Hudson bay use a grey soapstone for making all their kettles and lamps, which are frequently more than two feet in length. It is of a tough and durable variety. As nearly as I could ascertain from them, the soapstone is obtained not far from Mosquito bay, latitude 60° 45′." (Geol. Surv. Can., Rep. Prog., 1877-8, p. 24C.) Bell also mentions Skynner's cove, north side of Nachyak inlet, on the Labrador coast, as a locality from which the Eskimos obtain soapstone for making their pots. (Geol. Surv. Can., Rep. Prog., 1882-4, p. 15DD.)

W. McOuat mentions the occurrence of considerable bodies of steatite on the west side of lake Opasatika, and on the Quinze river, Upper Ottawa river. (Geol. Surv. Can., Rep. Prog., 1872-3, p. 132.)

QUEBEC

Argenteuil County

TOWNSHIP OF GRENVILLE

Range II, lots 26 and 27. An occurrence of altered pyroxene exists on these lots, the material being of a greenish-brown colour and containing small mica flakes. The pyroxene is to a large extent only partially altered, and the rock exhibits the original grain, with some development of compact material on slip faces. The material is, perhaps, to be classed as pyrallolite. An analysis of material (probably a selected sample) from this deposit is given in the Geology of Canada, 1863, p. 470, and shows:—

Silica	61·60
Magnesia	31·06
Ferric oxide	1·53
Water	5·60

A sample, collected in 1920, and analysed in the Mines Branch laboratory, yielded the following:—

Silica	58·96
Ferrous oxide	1·01
Ferric oxide	0·58
Alumina	1·03
Lime	1·16
Magnesia	30·96
Carbon dioxide	0·85
Water above 105° C.	5·48
	100·03

The powder in this case exhibited a strong pink cast.

A small pit was opened on the deposit, alongside the road between Calumet and Pointe au Chene, many years ago, but little of the material is reported to have been shipped.

Similar material occurs on lot 16 in the same range of Grenville township, near the foot of the falls on Calumet creek.

EASTERN TOWNSHIPS

Beauce County

RIGAUD — VAUDREUIL SEIGNIORY

An occurrence of soapstone is recorded[1] by B. R. MacKay, on the St. Victor river, three miles west of the Chaudiere river. The deposit is described as a belt 30 feet wide, forming the northern rim of the St. Victor gorge for a distance of 1,100 feet below the lower falls. The rock occurs as a contact zone between an intrusive dunite and a slaty conglomerate, and is regarded as an alteration product of the dunite. Numerous veinlets of magnesite and fibrous serpentine cut the dunite and soapstone. The soapstone is much jointed and fractured, and for this reason is considered unsuitable for cutting into slabs or blocks.

Brome County

TOWNSHIP OF BOLTON

Range II, lot 26. A deposit of yellowish-grey, schistose talc occurs on this lot, and has been worked in a small way by the owner, George R. Pibus, of Knowlton, Que. A pit 15 feet deep and 6 feet square has been opened on the deposit, and discloses a band of about 7 feet of talc of good quality. In common with the talc of most of the other deposits examined in the Eastern Townships of Quebec, the material is thinly laminated and breaks up rather readily into thin sheets. The colour is lighter than that of the material of the other deposits examined, and the alteration of the original rock to talc seems to have been more pronounced in this case.

Outside the pit referred to above, little work has been done on the property; and, owing to the heavy overburden, few outcrops are to be seen. Considerable trenching would have to be done to prove the deposit. The owner reports traces of talc for a distance of 400 feet along the strike of the band exposed in the pit.

A sample of the talc from the main pit on this property gave a powder of a cream shade, possessing excellent slip. An analysis, made in the Mines Branch laboratory, yielded:—

Silica	59·78
Ferrous oxide	3·96
Ferric oxide	0·44
Alumina	1·82
Lime	0·02
Magnesia	29·23
Carbon dioxide	0·02
Water above 105° C.	4·79
	100·06

As in the case of most of the talcs from localities in the Eastern Townships, the iron oxide content is rather high, and the powdered talc is not pure white.

[1] Geol. Surv. Can. Memoir No. 127, 1921, p. 87.

The property lies 6 miles southeast of Knowlton station on the Knowlton and Brome branch of the Canadian Pacific railway, about one-half mile off the road between Knowlton and Bolton. The distance from South Bolton station, on the Eastman and North Troy branch of the Canadian Pacific railway, is 5 miles. A good road leads to both the above rail points.

Talc is also reported[1] to occur on range VI, lot 24, and range VII, lot 24, of Bolton township. The material is "dark coloured and very impure, containing numerous crystals of magnesian carbonate." The deposit on range VI, lot 24, is stated to have been worked in 1871, and 300 tons of material shipped.

TOWNSHIP OF POTTON

Range IV, lots 17 and 18; range V, lot 18. These lots were diamond drilled during 1920 by the Talc Development Company of Canada, Ltd., a subsidiary of the Eastern Talc Company, of Boston, who report that the drilling operations have revealed a considerable body of talc. No further developments have taken place up to the time of writing (December, 1921).

Range V, lot 28. Talc similar to that on range II, lot 26 of Bolton township, is reported to occur on this lot. An analysis of "green white steatite" from Potton township (lot and range not stated) is recorded in the Geology of Canada, 1863, p. 470, as under:—

Silica	59·50
Magnesia	29·15
Ferric oxide	4·50
Alumina	0·40
Water	4·40
	97·95

Megantic County

TOWNSHIP OF BROUGHTON

Range VII, lot 14. Steatite is reported[2] to occur on this lot, the material being of good grade but the deposit small. J. A. Dresser records[3] that "soapstone has been quarried to a small extent at the old Fraser mine at East Broughton, on range VII, lot 14, and on lot 5, range V, of Thetford. A considerable quantity is easily available on lot 2, range XI, of Broughton, and Ham, lots 42, 43 and 50, range I." The writer visited the first locality in 1919, but was unable to locate the deposit or to learn details of the work done. Dresser states that "steatite or soapstone—as well as the purer forms of talc —occurs in numerous places in the townships of East Broughton (?), Broughton and Ireland. It generally bears the same relation to the older serpentine that pyroxenite has to peridotite. It is an altered form of pyroxenite, and in some places shows distinct pseudomorphs of steatite after pyroxene."

While talc and soapstone are not uncommon in the Broughton district, the occurrences of the former would appear to be in the nature of thin bands or seams. The soapstone, also, does not appear to exist in large quantity, and, in addition, is too fissile to be worth quarrying for slabs or blocks.

1 Geol. Surv., Can. Summary Report, 1911, p. 292.
2 Geol. Surv., Can. Vol. X, 1897, p. 225S.
3 Geol. Surv., Can. Summary Report, 1909, p. 198.

TOWNSHIP OF INVERNESS

Range I, lot 1. Owned by Mrs. R. J. Briggs, Clapham, Que. This property lies about 1½ mile north of that of W. J. Porter, in Ireland township (described below), and discloses similar geological associations. Several small surface pits have been opened on outcrops of whitish talc, occurring as narrow veins in green talc and chloritic schists. The small amount of stripping is insufficient to indicate the extent of the deposits. The property lies 10 miles from Thetford station, on the Quebec Central railway.

TOWNSHIP OF IRELAND

Craig's Road range, lot 2. A number of narrow veins or seams of foliated talc, none of them exceeding one foot in width, occur on this lot. The talc has a pale green colour and occurs as aggregates of large flakes (crystals), often associated with large crystals of ankerite. The crystalline talc grades into talc and chloritic schists, which form the country rock. These schists are rather more compact than the average rocks of similar type in this region, and it is possible that massive soapstone suitable for cut slabs might be obtained here. The small amount of work done on the property is insufficient, however, to indicate the extent of the soapstone bodies, though, from surface indications, they apparently occur over a great part of the lot, and possibly, also, on adjoining lots. Small crystals of magnetite and ankerite occur rather plentifully disseminated through certain parts of the soapstone, but the rock as a general thing seems to be homogeneous in composition and uniform in grain. It possesses a dark, blackish-green colour when freshly broken, and weathers grey-green.

The soapstone bodies probably possess more potential economic importance than the talc veins, since the narrowness and impersistence of the latter render profitable exploitation problematical. The quality of the talc is, however, excellent, though considerable cobbing would be necessary to free it entirely from the associated ankerite.

The only work done on the property consists of a small amount of prospecting by means of surface blasting, and the stripping of the largest vein of talc so far located for a distance of about 25 feet. Surface indications would appear to warrant more development work on the property.

The property is owned by W. J. Porter, of Clapham, Que., and lies 13 miles from Black Lake station, on the Quebec Central railway. Some years ago, a company, the Megantic Talc Company, Ltd., of Toronto, was formed to exploit the talc and soapstone on this lot, but active work was never undertaken and the options are understood to have lapsed.

A sample of the clear, green, flaky talc from the main vein on this property was analysed in the Mines Branch laboratory and yielded:—

Silica	60·86
Ferrous oxide	1·11
Ferric oxide	0·24
Alumina	0·22
Lime	0·08
Magnesia	32·19
Carbon dioxide	0·09
Water above 105° C	4·50
	99·29

The powder is a fine white, and possesses high slip.

TOWNSHIP OF THETFORD

Range V, lot 5. There is an exposure of grey-green mottled talc on this lot, and some years ago a short drift was run into the hillside to cross-cut the deposit. The outcrop is on the south side of a low ridge, and the talc band dips south, with the slope about 45°. The workings lie on the land of Mr. Bisson, of Robertson.

The talc is soft and very fissile, breaking up readily into paper-thin sheets. On this account it would be useless for blocks or cut slabs. It contains few visible mineral impurities, and yields a greenish-grey powder possessing good slip. It would be suitable as a filler or loader in paper and rubber, for paints, or for foundry facings.

As exposed in the cut through the deposit, there appears to be about 12 feet of talc, forming a band in serpentine, but the inner end of the drift is still in talc. Asbestos and picrolite occur on slip faces in the serpentine.

The deposit is well situated for working, and lies one-fourth of a mile off the main road between Thetford and Robertson, and 3 miles from Robertson station on the Quebec Central railway.

The band of talc or soapstone described as occurring on this lot can be traced by scattered outcrops for several miles along the ridge on the north side of the valley through which runs the Quebec Central railway. The most westerly outcrop seen was at a point a few feet north of the main pit of the Federal Asbestos Company, at Robertson, on Thetford V, 9. Here about 10 feet of talc are exposed in a small pit, the material being rather more massive than that farther to the east.

On Thetford V, 7, at a point about midway between the two occurrences described above, a small opening was made in the same band of talc, during 1920, by T. Demers, of Thetford, and 100 tons of crude talc are reported to have been shipped to a rubber firm in the United States.

It is stated that the continuation of this talc band has been traced eastward to the Berlin or Kitchener asbestos mine, 3 miles east of Robertson. The average width of this band, as shown in the three exposures examined, is about 10 feet; there is, therefore, a very large tonnage available.

Analyses of representative samples of talc from the three outcrops examined are given below:—

—	1	2	3
Silica	59·62	54·88	59·66
Ferrous oxide	4·25	4·63	4·12
Ferric oxide	1·21	1·44	0·37
Alumina	1·40	3·59	1·67
Lime	none	1·10	none
Magnesia	28·49	27·22	29·26
Carbon dioxide	trace	1·52	none
Water above 105° C	4·61	5·86	4·90
	99·58	100·24	99·98

1. Exposure at Federal Asbestos Company's mine, Thetford, V, 9.
2. Workings of T. Demers, Thetford, V, 7.
3. Workings on Mr. Bisson's land, Thetford, V, 5.

Richmond County

TOWNSHIP OF MELBOURNE

Range IV, lot 23. A small exposure of steatite was worked on this lot in 1918 and 1920 by the Canada Paper Company, of Windsor Mills, Que., the material being reported as used for lining the calcining furnaces of their sulphate pulp plant. About 200 tons are reported to have been mined and shipped.

The steatite occurs as a narrow band on a shear zone in a much altered igneous rock, and has been worked by stripping the face of a low bluff, the band paralleling the bluff. The opening made in 1919 disclosed a maximum thickness of one foot of massive, grey-green talc of good grade, but much squeezed and traversed by slip planes. The material is quite friable, and could hardly be cut into blocks of any size.

The deposit is on the land of the New Rockland Slate Company, 408 Merchants Bank building, Montreal, and lies about one mile from Kingsbury station, on the Orford Mountain branch of the Canadian Pacific railway.

Wolfe County

TOWNSHIP OF WOLFESTOWN

Range II, lot 20. According to Ingall,[1] this lot was actively worked prior to 1897, 3,000 tons of soapstone being reported as taken out. The workings, now visible, would suggest that the above quantity is considerably in excess of the amount actually secured. Ells[2] states that in 1889 the property was worked by Messrs. Fenwick and Sclater, of Montreal, who in that year shipped 150 tons to Montreal. The material was ground and consumed in the paint and lubricant trades, being valued at $6 per ton f.o.b. cars at Coleraine station. Ells further states that "the bed of soapstone which is worked is near the contact of the crystalline schists and lower black Cambrian slates, and has a width of from one to ten feet where quarried on the bank of the stream." The last important work on the property was that referred to above. A few tons were taken out by the present owner, Joseph Martel, of Wolfestown, in 1912, and ground in his grist mill near the deposit. This material was sold to the Asbestos Foundry Company, of Thetford, Que., for use in foundry facings. A sample of the ground talc, furnished by the owner, proved to be smooth, free from grit, and to exhibit a yellowish cast.

The old pit from which most of the soapstone was taken lies close to the bank of White river, where it is crossed by the road from Coleraine to Wolfestown Corners. The distance to Coleraine station, on the Quebec Central railway, is six miles. This pit is now inaccessible on account of flooding, and no examination of the deposit was possible. The owner states that the best soapstone found was taken from this opening, which is 20 feet deep.

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1 Geol. Surv. Can., Vol. X, 1897, p. 225S.
2 Geol. Surv. Can., Vol. IV, 1888-9, p. 152K.

A sample of the ground soapstone, supplied by the owner, was analysed in the Mines Branch laboratory and yielded:—

Silica	58·48
Ferrous oxide	3·64
Ferric oxide	1·04
Alumina	2·33
Lime	none
Magnesia	29·50
Carbon dioxide	none
Water above 105° C	4·97
	99·96

Other Localities in the Eastern Townships, Quebec

Yellow and grey talcose slate is mentioned as occurring on lot 13, range IX, township of Stanstead, Stanstead county; and a similar material on lot 17, range XIII, township of Leeds, Megantic county. (Geol. Surv. Can., Ann. Rep. IV, 1888-9, p. 118K.)

CHAPTER III

TALC AND SOAPSTONE

GENERAL INFORMATION

Talc. Talc is a soft, mica-like mineral. It is an acid metasilicate of magnesium, corresponding to the formula $H_2O.\ 3MgO.\ 4SiO_2$, with 63·5 per cent of silica, 31·7 per cent of magnesia, and 4·8 per cent of water. The colour is commonly a pale, apple-green, grey or creamy white. Talc exhibits a pearly lustre on cleavage surfaces, has hardness 1, specific gravity 2·7, and is distinctly greasy to the touch. It is translucent, even in fairly thick pieces. It is fusible with difficulty on thin edges, and is not affected by ordinary acids. It gives off its water of composition only at red heat, and is stable under a wide range of physical and chemical conditions. Talc crystallizes in the monoclinic system, but well-formed crystals are rare. Talc is essentially a secondary mineral, and usually occurs as the principal constituent of magnesian rocks that have undergone intensive metamorphism, the more usual types of such rocks being dolomite, peridotite, dunite, and pyroxenic rocks generally. The amount of talc present in such altered rocks is dependent on the degree of metamorphism to which they have been subjected, and pyroxene is often found in all stages of alteration to talc. Common pseudomorphous minerals, intermediate between pyroxene and talc, are rensselærite and pyrallolite.

Talc differs in chemical composition from serpentine only in the proportions of silica, magnesia, and water present, both belonging to the same group of minerals. Talc is also closely related to the chlorites and micas. Many so-called soapstones consist of a mixture of talc and the above minerals.

Talc may occur in a variety of forms, depending on the minerals from which it has been formed, and the metamorphic processes to which they have been subjected. Some talcs occur in thin, mica-like scales, others in plump, shapeless folia, while some are distinctly fibrous. Examples of micaceous talcs are to be found in the deposits of the Eastern Townships, Quebec; foliated talc is typical of the altered dolomite of the Madoc district, Ontario; and fibrous talc—in this case an alteration product of tremolite—forms the bulk of the talc produced in the Gouverneur district, New York. When freely crystallized, talc commonly forms globular or stellate groups of scales or leaves; in this form, it is sometimes found in narrow veins traversing massive bodies of talc or soapstone.

Few of the commercial bodies of talc that form the source of the world's supply consist of pure talc, there being usually a certain amount of unaltered, or only partially altered, original, mineral substance present. In addition, other secondary minerals may have been formed simultaneously with the talc. The commoner of such accessory minerals found in talc bodies derived from magnesian limestones are dolomite, magnesite, calcite, quartz, and tremolite. In the darker coloured talcs, derived from such rocks as peridotites or pyroxe-

nites, there may be an appreciable amount of serpentine, chlorite or sericite present; these talcs, contrasted with the foregoing, are generally relatively free from dolomite and other carbonates.

Steatite. Steatite is the name generally applied to the massive, compact, crypto-crystalline form of talc. Steatite is far less common than ordinary talc. It is usually of a cream to light greenish colour. The name steatite is sometimes erroneously applied to soapstone. Steatite is not commonly found in large masses. It is not rare as an alteration product of pyroxene or quartz, and steatite pseudomorphs after these minerals are well known. When in sufficiently large masses to be worked, steatite finds employment for lava purposes, in the manufacture of gas tips.

Soapstone. Soapstone is rather an elastic term, used originally to designate a soft, compact rock consisting largely or in part of talc. By reason of the talc content, such a rock is characterized by its greasy or soapy feel, the ease with which it can be sawn or worked, and its general resistance to the action of corrosive chemicals and heat. Such soapstones are practically always of secondary origin; that is, they are rocks, usually of high, original magnesia content, that have undergone pronounced metamorphism, with conversion of the original magnesian minerals to the hydrous silicate of magnesia, talc. Such rocks may have been originally of a sedimentary nature, such as dolomite, or, more commonly, of igneous origin, such as peridotite, dunite, pyroxenite, or amphibolite. Depending on the conditions obtaining during metamorphism, and also on the degree of such metamorphism, rocks of the above types may yield either serpentine or talc. Serpentine is a basic orthosilicate of magnesia, talc an acid metasilicate; and while the former is readily decomposed and alters easily, talc is one of the most stable of mineral species. Many serpentines contain admixtures of talc, and when the original rocks are at all aluminous, chlorites may also appear. F. W. Clarke[1] has discussed the origin of talc and serpentine, and observes that much work remains to be done in order to determine satisfactorily the origin of soapstone generally.

It is obvious from what has been said that soapstone may be a material of varying mineral composition, while retaining the same general physical character. In the better grades, the rock consists principally of talc, and the alteration of the original minerals to talc has been attended by destruction of their crystal outlines and the formation of a dense, compact rock showing little or no grain, and of uniform softness. Such high class soapstone is rare and commands a high price. Commercial soapstones are commonly mixtures of serpentine, chlorite, talc, and dolomite; quartz and calcite may also be present.

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[1] Clarke, F. W., Data of Geochemistry, Bull. 695, U.S. Geol. Surv., 4th Ed., 1920, pp. 605-9.

Merrill gives[1] the following six analyses of commercial, American soapstones, made in the laboratory of the U.S. National Museum:—

—	1	2	3	4	5	6
Silica	42·43	51·20	38·37	52·70	40·03	33·47
Iron oxide	13·07	8·45	8·86	7·63	9·59	7·38
Alumina	6·08	5·22	5·64	5·57	10·86	0·45
Lime	3·27	1·17	3·90	1·77	1·70	1·34
Magnesia	25·71	26·79	28·62	26·88	26·97	33·72
Water	8·45	6·90	14·49	5·48	10·78	23·00
Total	99·01	99·73	99·88	100·03	99·93	99·36

1. Francestown, New Hampshire.
2. Grafton, Vermont.
3. Dana, Massachusetts.
4. Baltimore county, Maryland.
5. Guilford county, N. Carolina.
6. Lafayette, Pennsylvania.

The excessive amount of water shown in Nos. 3, 5, and 6 of the above analyses would suggest that this percentage represents the loss on ignition, and thus includes also carbon dioxide.

An analysis of Alberene stone, quarried extensively in Virginia and widely used as a soapstone on this continent, and of a similar stone recently found near Wabigoon, western Ontario, are given on page 36.

Two additional analyses of Alberene stone, quoted by Merrill,[2] and of a soapstone from the adjoining Fairfax county, Virginia, are given below.

—	1	2	3
Silica	39·06	38·85	58·40
Iron oxide	12·90	12·86	7·44
Alumina	12·84	12·77	
Lime	5·98	6·12	none
Magnesia	22·76	22·58	29·19
Alkalies	0·30	0·30	none
Loss on ignition	6·56	6·52	4·97
Total	100·40	100·00	100·00

1 and 2. Alberene stone, Albemarle county, Virginia.
3. Soapstone from Fostoria, Fairfax county, Virginia.

USES OF TALC AND SOAPSTONE

From the foregoing remarks on talc and soapstone, it will be apparent that soapstone, in its better grades, may be regarded as an impure talc, while many so-called soapstones may contain relatively little talc. While soapstone, as such, is usually utilized in the massive form, as slabs, blocks or bricks, nearly all talc finds employment in industry as a fine powder, its principal use being as a filler or loader to give body and substance to a variety of products.

[1] Merrill, G. P., The Non-Metallic Minerals, 2nd Ed., 1910, p. 209.

[2] Merrill, G. P., Rocks, Rock Weathering and Soils, 1921, pp. 95, 211-2.

The uses of talc, and the mining and milling methods employed in the different producing areas in the United States, together with various questions relating to the talc industry in general, have been studied in great detail during the past few years by R. B. Ladoo, of the United States Bureau of Mines. The results of Mr. Ladoo's work have appeared in a series of Reports of Investigations, published by the above Bureau, and to these reports the writer desires to make his acknowledgments for much of the information given below. A list of the more important reports on the subject of talc and soapstone, issued by the United States Bureau of Mines, will be found in the Bibliography at the end of this report.

In 1915 producers of talc and soapstone in the United States formed an association known as the Talc and Soapstone Producers' Association. Among the aims of this association were the extending of the uses of talc, the standardizing of ground talc, and the investigation of milling processes with a view to improving present methods. The standardizing of ground talc is a difficult problem, since talc, in common with many other non-metallic minerals that find employment as mineral fillers, varies considerably in colour, grain, and the amount of mineral impurities present. The specifications of consumers of ground talc, also, exhibit an equally wide variation in the fineness demanded, permissible amount of impurities, moisture, etc., and general requirements, and this discrepancy holds good even among consumers manufacturing similar products.

Powdered Talc

Nearly sixty uses of powdered talc are listed by R. B. Ladoo in one of his reports[1] on the uses of talc and soapstone (10). Many of these uses are of secondary interest and are only briefly alluded to here.

The properties that give talc its importance in industry are its softness and slip, relative infusibility, resistance to acids or alkalies, and its general stability under a wide range of physical and chemical conditions. Talc shares with graphite many of the above properties; but, on account of its white or light colour when powdered, talc can be used where graphite cannot; as, for instance, in paper and light coloured paints. For some purposes, as in foundry facings and lubricants, graphite and talc may be used to some extent to replace one another.

Probably 90 per cent of the total powdered talc used on the American continent is consumed in the following five industries: paper, roofing felt and paper, textile, rubber, and paint.

Paper

Talc functions in several ways in the manufacture of paper. It serves as a filler or loader to give body to the paper, and as an ingredient of the surfacing mixture on glazed and finished papers.

Talc is not used[2] so much as clay in loading paper, but is extensively employed in paper-coating mills. Talc improves the printing qualities and feel

[1] The numbers in brackets in the text refer to the different reports of the U.S. Bureau of Mines listed in the Bibliography.

[2] Sutermeister, E., Chemistry of Pulp and Paper Making, 1920, p. 300.

of paper and gives it a raglike appearance. It is said that 20 per cent of talc will give as good results as 30 to 40 per cent of china clay.

For loading paper, the fibrous variety of talc known as agalite or asbestine (mined extensively in the Gouverneur district of New York state) is preferred to the foliated variety. Being fibrous, it attaches itself well to the paper fibres and gives good retention. Like foliated talc, it imparts a greasy feel to the paper, though it does not give as high a finish as that variety. Agalite, asbestine, talc, French chalk, mineral pulp, are all terms used loosely by paper makers for the same substance.

The specifications for a paper talc vary with the purpose for which it is required. Fibrous talc is generally preferred to foliated or massive talc for the reasons stated. The fineness should be 200 mesh, and freedom from grit is essential. The talc should contain little or no calcite or other minerals that will be affected by the chemicals commonly present in the pulp. A good white colour is demanded for white papers, but colour is not so important for the lower grades.

Roofing Felt and Paper

Large quantities of lower grade talc are used in the manufacture of the so-called ready roofing materials. Much of the lowest grade talc, consisting of a mixture of the grit and coarse talc particles from the talc mills, is used for this purpose. The talc serves as a filler or loader in the body of the paper, as a surfacing material to increase its weather-resisting qualities, or as a coating medium to prevent sticking.

The specifications for roofing talc call for a fineness of 150 mesh for the filling and coating grades, and 40 to 80 mesh for the surfacing grades. The colour is not important, and the presence of other minerals, within reasonable limits, is not objected to. Such minerals as pyrallolite and rensselærite (which are pyroxene in process of alteration to talc), soapstone, actinolite, low grade asbestos, and even serpentine, are sometimes employed in place of talc for roofing purposes.

Textiles

Talc is employed to a considerable extent as a filler in textiles. Other substances used for the same purpose are china clay, gypsum, whiting, and blanc fixe. For this purpose talc requires to be ground to pass 200 mesh, and as a general thing only the pure white talcs are employed.

Rubber

Talc is used[1] in practically all lines of rubber manufacture, chiefly for preventing sticking of surfaces during handling or vulcanizing It is used to dust the moulds in order to keep the gum from sticking to the metal, and to bury white goods to keep them in shape during vulcanizing.

Talc is used to some extent as a filler or loader of rubber goods, but the use of an excessive amount produces a stony effect in the product. It may be employed to advantage, however, in semi-hard packing.

[1] Pearson, H. C., Crude Rubber and Compounding Ingredients, 1918, p. 112.

Paints

Increasing quantities of talc are being employed in paint manufacture. The talc most generally used is the fibrous variety asbestine, obtained from the Gouverneur district, New York state. The chief merit of this talc for paint is that, being fibrous, it is comparatively bulky or fluffy[1] and absorbs considerable oil. Owing to its low specific gravity, it does not tend to settle so readily as china clay, which it has largely displaced in paints. In inferior grades of paints, asbestine serves to hold the barytes used in suspension. Heckel, however, states[2] that the fibrous variety of talc is not always most desired by paint manufacturers. While an advantage in some types of paints, fibrous talc is objected to in others on account of its bulk and because the fibres have a tendency to arrange themselves end up on the painted surface, thus causing roughness. For these reasons, heavy, granular talcs are often specified by paint manufacturers, in place of light, fibrous talcs.

Asbestine is used in so-called fireproof paints, employed to protect shingles and woodwork from fire hazard. In this connection, Toch[3] remarks:—

> It is proper to say that there is no such thing at the present time as a fireproof paint. It is perfectly possible to make a fire-resisting paint, but these paints are usually of the casein-whiting (kalsomine) type, which resist fire for a little while. Oil paints containing boracic acid and powdered asbestos[4] are used as shingle paints, as they resist ignition from sparks.

Heckel gives the following formula for a so-called fire-resistant paint:—

Basic sulphate white lead	18·60	pounds
Zinc oxide	11·00	"
Asbestine (talc)	33·00	"
Borax	0·50	"
Lamp black	0·90	"
Pigment	64·00	"
Linseed oil	24·00	pounds
Liquid dryer	2·00	"
Mineral spirits	10·00	"
Vehicle	36·00	"

The problem of fire-resistant paints has been studied recently by the Paint Manufacturers' Association of the United States, and research work on the subject has been carried on by Dr. H. A. Gardner, at the Institute of Industrial Research, Washington. Paints of the above general type have been given the title Pamak by the Association, and are stated to have been endorsed by the Lumber Association.

Talc for paint use is required to be ground to 200 mesh. As stated above, both foliated and fibrous talcs appear to have their merit. The colour demanded is dependent on the use, and mineral impurities within limits are not objectionable.

[1] Sabin, A. H., Technology of Paint and Varnish, 1917, p. 189.
See also Ladoo, R. B., U.S. Bur. Mines (8).

[2] Heckel, G. B., Asbestos, Vol. II, July, 1920, pp. 5-10. See also Ladoo, R. B., Talc in Fire-Resistant Paint, Serial No. 2150, Reports of Investigations, U.S. Bureau of Mines, August, 1920, p. 2.

[3] Toch, M., The Chemistry and Technology of Paints, 1916, p. 128.

[4] Probably asbestine is meant.

Foundry Facings

Considerable quantities of talc are used in the manufacture of foundry facings, in which the talc either replaces graphite or is mixed with graphite. There seems to be a prejudice among foundrymen for the weathered, rusty or red talc from the Southern States, more especially the Bull Run talc from Virginia.

Toilet Preparations

Probably the most widely known use of talc is in talcum face and toilet powders. Scott[1] gives the following as the composition of an average talcum powder:—

Powdered talc	22 parts
Magnesium carbonate	2 "
Boracic acid	1 "

Talc is also used in other toilet preparations, such as creams, pastes, lotions, soaps, etc.

Only superfine grades of white talc can be employed for the above purposes. The white, foliated talc of the Madoc district, Ontario, is in great demand for talcum, as are also the Italian and Californian talcs. The powder should pass 200 mesh, contain no grit, and possess good slip.

Other Uses

Among the other uses of talc, the following are perhaps the most important:—

Soap. Talc may be used as a filler.

Lubricants. On account of its softness and low coefficient of friction, talc possesses good lubricating properties, and may be employed, like mica and graphite, mixed with greases or heavy oils, to form lubricating compounds. A pure, grit-free talc is a prerequisite for such purposes.

Linoleum and oil cloth. As in the rubber trade, talc is employed as a filler, and for dusting surfaces during manufacture.

Pottery. A small amount of talc is sometimes used in pottery bodies, for cooking ware. It is said to impart toughness and resistance to sudden temperature changes, and promotes translucency and vitrification. It has also been used to advantage as a constituent of porcelain glazes.

Leather. Talc is used in the dressing of hides and leather.

Minor uses are: in rope and twine manufacture; for polishing plate glass; dusting glass bottle moulds; as an ingredient of special cements, concrete, plaster, imitation stone and composition flooring; imparting a polish to rice and other grains; in acid and fireproof packings and cement; as an ingredient of insecticide dust preparations; shoe polish.

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[1] Scott, W. G., White Paints and Painting Materials, 1910, p. 129.

Massive Talc or Steatite

Pure talc is seldom found in such a sufficiently massive and compact form that it can be cut into large pieces possessing the necessary strength to withstand hard usage. Accordingly, the uses of steatite are limited, and are confined for the most part to objects of small size or to such as are not subjected to shock or strain. High grade steatite, being scarce, commands a high price, and is in special demand for lava purposes—gas burner tips, etc.

Steatite for all purposes should be quite compact and without visible grain. It should be free from iron and grit, and exhibit no flaws, checks, cleavage, or parting planes. Lava talc, in particular, must be free from lime and included moisture, and must be capable of withstanding considerable heat. Colour is not of importance, but pure steatites are generally of a light cream, yellow, or greenish shade.

The principal uses of massive talc are given below.

Lava

The following notes on lava talc are taken from a report by R. B. Ladoo (1):—

The term Lava was first used as a trade name for block talc which has been subjected to heat treatment, but now it has come into more common use and is applied not only to block talc, but to articles made from a synthetic compound which may contain little or no talc.

The valuable properties of finished lava are great hardness and tenacity, resistance to high heat, acids and alkalies, high compressive strength and high dielectric strength. It is harder than glass. It has a compressive strength of 20,000 to 30,000 pounds per square inch; is not affected by heat below 1100° C.; and is unaffected by alkalies or acids, except hydrochloric acid, which attacks it but slowly. Its dielectric strength is 75 to 250 volts per thousandth of an inch in thickness.

Lava is used in a great variety of forms for gas tips and burners, and for electrical and heat insulation. As all of the machining is done before the talc is baked, an almost infinite variety of forms may be made. Such forms are limited only in size, for only articles not much over 12 inches in length can be made satisfactorily of true lava.

Talc suitable for the manufacture of lava must be fine-grained, homogeneous, compact, fairly soft, and lacking in cleavage, or cleavage must be very poor. It must contain little or no water, must be free from grit and low in iron. Massive talc for this use is found in British India, Italy, France, Germany, and the United States. One of the characteristics of the best talcs is that a surface, which has been scraped by a sharp knife, presents a semi-polished appearance. This is best exhibited by the Indian, Italian, and German talcs. Fineness of grain, and freedom from grit are essential if very small holes or slots are to be cut. The presence of iron as an impurity lowers the dielectric strength. Included moisture causes the talc to swell and split during the baking process.

Talc for lava manufacture is bought from producers, either cut to size, in small cubes, or in large, roughly squared blocks, 12 to 18 inches in diameter. As many of the shapes of lava are made to order, the large blocks are held in stock for cutting into special sizes. The small blocks, cut approximately to the outside dimensions of the finished articles, are placed one at a time in small, high speed lathes where the preliminary cutting is done. They then pass to a succession of lathes, drills, and saws where the blanks are turned, threaded, drilled, and slotted. After the machining is done, the lava in the green state is placed in small ovens or kilns, heated by electricity or gas. There, they are subjected to a temperature of about 1100° Centigrade (2000° Fahrenheit) for between 24 and 48 hours. There is practically no shrinkage in the baking process. This makes possible the manufacture of articles in which accuracy of size is important. After removal from the kiln, the lava articles are allowed to cool, and then are carefully examined and tested. Gas burner tips are usually mounted in brass or nickel plated holders.

Composition or synthetic lava is made from ground talc, or other material, mixed with a suitable binder. The resulting mass is thoroughly mixed and then formed under high pressure into rods, slabs, or tubes. These blank forms are first air dried, then kiln dried at a moderate temperature. The resulting material may then be machined and baked by the methods used for true lava. Composition lava is lighter in weight, and more porous than true lava, but is more suitable for some purposes than that made from massive talc.

An article published in Economic Geology[1] contains much information on the known occurrences, composition and properties of lava talc, and the following notes are taken from it.

The manufacture of gas tips from talc in the United States centres chiefly in Chattanooga, Tennessee. Several factories are also located in New York.

The production in the United States of talc suitable for gas tips has been limited to North Carolina, Georgia, and Maryland. The total output of the grades suitable for gas burners in recent years has been very small, and the supply is far from sufficient to meet the demand. The total amount used annually in the United States probably does not exceed 1,000 tons.

The most common mode of occurrence of talc suitable for gas burners is in metamorphic limestone, but some is also obtained from deposits in altered, basic igneous rocks.

Good lava talc is obtained from Wunsiedel in Germany, Italy, and India. The German steatite is probably the best of all for lava purposes, the constituent particles being so minute that the material has practically no grain.

For more detailed particulars on the subject of lava talc, reference should be made to the article noted.

Crayons and Pencils

Massive talc is used, cut into thin strips or rods, for marking steel and iron. Common dimensions for steel-markers' crayons are: $1\frac{1}{4}$ x $\frac{1}{4}$ x 5 inches; $\frac{1}{2}$ x $\frac{1}{2}$ x 5 inches; $\frac{3}{8}$ x $\frac{3}{8}$ x $3\frac{1}{2}$ inches. The quality of talc for this purpose need not be high, provided that the material be sufficiently compact and massive to possess a fair degree of strength in thin pieces. Pencils and crayons are sawn from blocks of steatite, shaped to rectangular dimensions, by means of specially tempered circular saws.

Talc suitable for the above purpose may also be worked up into the shapes known as tailors' chalk, but much of the tailors' chalk used is a composition product. Pyrophyllite, a hydrous silicate of alumina, resembling talc in its general properties, is also used for this purpose, as well as for a variety of other purposes for which talc is employed.

Other Uses

Steatite is used by orientals for carved images and art objects, but much of the so-called soapstone used for this purpose is probably agalmatolite or pinite.

Small cubes of talc are used in tumbling machines, to fill the grain and give a polish to wooden handles, and to polish nails.

A recent use for steatite is for the manufacture of cores for electric heating elements.

Soapstone

Since the distinction between talc and soapstone is rather an arbitrary one, based on the relative purity of the material, it follows that equal latitude must be allowed in defining the uses of the two substances, and these uses may, therefore, overlap.

[1] High Grade Talc for Gas Burners, by J. S. Diller, J. G. Fairchild and E. S. Larsen, Economic Geology, Vol. XV, No. 8, December, 1920, pp. 665-73.

SOAPSTONE SLABS

Soapstone is used in large quantities for electrical switch board panels and base plates; acid proof laboratory table tops, sinks, tanks, hoods, cupboards and other equipment; laundry tubs and sinks. For such purposes, the stone must have considerable structural strength, and be free from cracks and flaws. A fine to medium-grained stone is preferred. Slab soapstone is also used to some extent for flooring, stairways, and window sills.

Of late, there is a tendency to replace soapstone for the above purposes by slate, owing to the more homogeneous character of the latter stone and its greater structural strength.

SOAPSTONE BLOCKS, BRICKS OR PLATES

Sulphate Pulp Mills

One of the most extensive uses of block soapstone is for lining the smelting furnaces of sulphate (kraft) pulp mills. In such mills, furnaces are used to smelt the black ash formed during the initial stage of recovery of the alkali in the waste liquor from the digesters. These furnaces are of stationary type and are lined with soapstone. Into them is introduced the black ash, mixed with sulphate of soda and sawdust, and the whole is then burned, the fused alkali being run out into a dissolving tank.

In addition to its resistance to fire and alkali under such conditions, soapstone has the merit of offering a surface to which the fused alkali will not adhere, and thus the furnace walls do not require to be cleaned.

The soapstone used in Canadian sulphate pulp mills is almost all imported Alberene stone from Virginia. It is difficult to obtain a structurally strong stone that will stand up under the combined attack of heat and alkali in such furnaces, and even the Alberene stone in general use has not a very long life. From six to nine months is stated to be a good average for an Alberene stone lining. The best soapstone for the purpose is obtained from Sweden, but the expense of importation prohibits its use.

The requirements in a soapstone for sulphate pulp furnaces are: fine to medium grain, compactness and homogeneous composition, and freedom from flaws and cracks. It should consist largely of talc, and contain no carbonates (dolomite, calcite) or pyrites. The stone should possess a massive, as opposed to a schistose texture, since schistose soapstone tends to spall readily and has little strength.

The discovery of a soapstone possessing the above characteristics, in Canada, would be of considerable benefit to domestic paper mills, since the quantity used is large and the cost of the imported stone high—from $5 to $6 per cubic foot, laid down.

The soapstone bricks used vary in size. Common dimensions are: 12 x 12 x 6 inches; 12 x 6 x 6 inches; 12 x 6 x 3 inches; 18 x 12 x 8 inches; 18 x 12 x 12 inches.

Other Uses

Soapstone possesses high heat retention, and for this reason it is of value for such articles as fireless cooker stones, foot warmers and griddles. Bake ovens may, with advantage, be built or floored with soapstone bricks.

Moulds for bottles and other glassware, as well as for casting certain metals, are sometimes made of soapstone.

Soapstone, on account of its refractory nature, may be used instead of firebrick, but, as a general thing, its cost is prohibitive for this purpose.

Soapstone was, and still is, used by aborigines in many parts of the world for making their cooking utensils.

MINING OF TALC AND SOAPSTONE

Talc

Talc is usually mined, not quarried, as are feldspar and mica. Soapstone for slab and block purposes is, however, quarried in the same way as marble or other structural stone.

Talc bodies are usually an alteration product of dolomite, pyroxenite, peridotite, etc., and are commonly found along or adjacent to the contact of such rocks with an intrusive. In some cases the alteration may be the result of dynamic metamorphism, while in others, both contact and dynamic metamorphism may have played a part.

As a result of their origin, talc bodies are generally fairly persistent, often maintaining their widths over considerable distances. Lens-shaped talc bodies are also common, having resulted from local squeezing, and such bodies are often found at the crests of pronounced folds.

Talc bodies are commonly found tilted in a steep attitude, and hence ordinary stoping methods may often be followed in mining. Sometimes several relatively narrow seams of talc may be exploited in the same set of workings, and this calls for care in the leaving of pillars to support the walls. In wet mines the slippery nature of the ore may cause trouble, and slips and caving have to be guarded against.

The following notes on talc mining methods in the United States are taken largely from reports of the U.S. Bureau of Mines.[1]

In Vermont the talc bodies are usually in the form of lenses, there being an outer shell of talc surrounding a core of so-called grit or cinder. This material may be, variously, impure talc or serpentine. In some cases it is mined with the talc, and in others left standing or taken out separately.

At the mine of the Vermont Talc Company, Chester, Vermont, a width of about 60 feet of talc is worked. The shaft is sunk on the hanging-wall contact, following the dip of the deposit. Levels have been run along the contact at 75 feet and 100 feet, and cross-cuts driven through the talc body to the foot-wall. The talc is won by stoping, the stopes being carried forward 15 to 20 feet wide. The talc and walls stand well, and high, wide stopes may be cut without timbering. Drilling is done with Sullivan jack-hammer drills. The large lumps of talc are conveyed direct to the mill, while the wet, run-of-mine fines are allowed to dry out under cover.

At the mines of the Eastern Talc Company, Rochester, Vermont, several talc veins, measuring about 15 feet in width, have been worked by means of overhand stoping, from stulls. Later, it was found that the grit bodies between

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[1] Ladoo, R. B., Talc Mining in Vermont; Talc Mining in New York; High Grade Talc and the California Talc Industry. Reports of Investigations, U.S. Bur. Mines.

the talc bodies proper could be exploited, and a different method of mining was adopted. The shaft is sunk on an incline of 45° in the wall rock, and when the talc body is reached levels are run in it, 175 to 200 feet apart. Cross-cuts are carried each way from the shaft to the walls, and drifts are then run from the ends of the cross-cuts in each direction to the limits of the ore-body. Raises are put up at frequent intervals, and at an angle of 45°, from both the drifts and cross-cuts. These raises branch and go to opposite walls at an angle of 45°; they are cut 10 by 15 feet and are not timbered. Talc is removed above the raises by overhand stoping, and the stopes are sometimes carried up to the level above, or a back pillar may be left. Stoping is then continued by underhand slicing or benching into the raises. The talc body is worked out retreating toward the shaft, and leaving large, open stopes, often 50 feet wide, 150 feet long and 200 feet high. The run-of-mine talc is dumped over a grizzly, the waste is picked out, and the lump talc goes to the dry bins, and the fines to wet bins.

The Magnesia Talc Company, Waterbury, Vermont, mine a talc body having a maximum width of about 125 feet. This body has a core of serpentine, and most of the talc has been won from between the core and the west wall. Thus, there may be said to be two talc veins, separated by a body of serpentine. The west vein varies in width from 4 to 50 feet, and dips 80° to the east. The mine has been opened by two adits. The lower adit is 150 feet below the upper, and is the one now used. It enters the hill on a level with the top of the mill, and has been driven in for 2,000 feet on the west wall. Local rolls and swells in the talc body, as well as horses of country rock (cinder), make the structure complicated, and often reverse the dip. Cross-cuts have been run at intervals to the east wall, where a drift has been carried for some distance. Raises are put up at 50-foot intervals, and branch at an angle of 45°. They are cut square the full width of the vein, and the talc is stoped out above them.

At the mine of the Foliated Talc Company, Rowe, Massachusetts, the vein measures about 60 feet thick of clear talc and dips 65°. It is opened by an inclined shaft sunk on the dip of the vein and reaching a depth of 240 feet. At 100 feet and 200 feet, levels are run in each direction along the vein, and stopes are started at intervals along both sides of these levels, pillars being left for support where necessary. No timber is required.

The Carbola Chemical Company, Natural Bridge, New York, works a talc body having a maximum width of 90 feet. Large horses of limestone occur in the deposit; these are usually left as pillars, but sometimes have to be taken out. The mine is opened by an inclined shaft, dipping at about 65°, from which levels are run along the ore-body at 100, 147, and 200 feet. The 100-foot level has been carried a total length of 600 feet, and from it most of the talc won has been obtained. Drifts have been run along the foot and hanging-walls, and are connected at frequent intervals by cross-cuts. Owing to the loose nature of the ground, the walls cannot always be followed closely, and the drifts are then run in the solid ore near the walls. For the same reason, the mine is a very wet one. Air drills of the jack-hammer and stoper types are used.

At the Wight mine of the International Pulp Company, near Gouverneur, New York, the talc body varies from 6 to 25 feet thick, and has an average dip of 35°. The mine is opened by an inclined shaft, sunk on the vein to a depth of 350 feet. Levels are run at every 50 feet, and are cut 20 feet high by 20 feet wide. Raises are put up every 30 feet or so to the level above, these raises being cut about 20 feet wide, and the entire width of the vein. No timbering is required. Air drills of jack-hammer type are used.

The Californian talc deposits are usually in the form of small, shallow lenses, and in character and mode of occurrence the talc is said to be similar to that of the Madoc district, Ontario. The deposits occur in an arid country, so that little or no pumping is required, and it is not necessary to dry the ore before grinding. All drilling is done by hand, and operators have to overcome severe transportation difficulties. At the mine of the Inyo Talc Company, near Keeler, California, the talc occurs as irregular lenses in dolomite. The talc bodies usually have a fairly steep dip, and are worked by adits driven in the dolomite hanging-wall. These adits are timbered. Cross-cuts are run from the adit to the ore-body, and drifts are run along the latter. The ore is broken by a system of block caving (stoping).

At the mine of the Pacific Coast Talc Company, Silver Lake, California, the talc occurs as irregular shoots, up to 7 feet wide, dipping at about 60°, in a schist country. The mine is opened by an incline shaft, sunk on the vein at an angle of 60°, and carried to a depth of 120 feet. At the 70-foot level, a drift is carried along the vein in the ore. From this drift, raises are put up and widened out into stopes. The ore is very soft, and drilling is done by hand steel or by augers.

The talc body developed at the Henderson mine, Madoc, Ontario, has the form of a flattened, inverted canoe, and dips at a steep angle to the south. It is enclosed in dolomite. The ore-body has an average width of about 35 feet, and consists of clear talc with no waste. Worked originally open cast, the deposit has in recent years been worked from two shafts, from which levels were run at 150 and 200 feet. The method of mining is that known as shrinkage stoping, and has been described by R. B. Ladoo[1] as follows: A cross-cut is driven from the shaft to the vein, and drifts are carried along the foot-wall, outlining the ore-body. At intervals of 20 feet, raises are put up, usually on the hanging-wall side. These raises are widened out into stopes the full width of the vein. Timbered ore chutes are provided at each raise, and additional man-way raises are cut where needed. The level of the broken ore in the stopes is kept close enough to the roof to render drilling easy, and ore is broken by overhand stoping until the old, caved in workings are reached. The stope is then considered finished, and the broken ore is drawn off through the chutes. The drift pillars keep the drift open, even after all the ore is drawn off. This method of working permits all the ore to be broken by overhand stoping, provides many working places, dispenses with shovelling and timber in the stopes, provides for storage of a large tonnage of broken ore, and keeps the ore relatively dry, since the stopes are self-draining.

[1] Talc Mining and Milling at Madoc, Ontario, Reports of Investigations, U.S. Bur Mines, September, 1920.

Soapstone

The only structural (slab and block) soapstone quarries of importance on the American continent are those worked by the Alberene Stone Company, at Schuyler, Nelson county, Virginia, and by Oliver Bros., Inc., at Arrington, also in Nelson county. These companies have extensive workings, and produce a large quantity of soapstone slabs, blocks, and bricks, which find employment for a variety of purposes.

The soapstone is won from large quarry openings, the stone being taken out in large blocks, which are cut out by channelling machines. The system followed is essentially the same as that used in marble quarrying,[1] and will be found very fully described in the report mentioned in the footnote.

According to R. B. Ladoo (18), the soapstone bodies worked by the above-named operators occur as separate, parallel beds, ranging from 30 to 165 feet in width, and up to 800 feet apart. The dip varies with that of the enclosing rocks, but at one quarry is 60°. The total width of the bands seldom consists of sound stone, the proportion of minable stone ranging from 50 to 85 per cent. A large amount of the rock moved consists of waste, owing to (1) the local presence of pyrites; (2) hard zones, which render the material difficult to saw; (3) flaws and cracks, which impair the structural strength of the stone. Further waste ensues in the sawing and finishing processes.

The blocks after being cut out by channelling machines are hoisted by derrick, and conveyed on flat cars to the sawing and working sheds. There the large blocks are cut up by means of gang saws into slabs and blocks of the required dimensions. These are then smoothed, trimmed, levelled, drilled, or slotted, as the case may be.

PREPARATION FOR MARKET

Powdered Talc

TRADE REQUIREMENTS

While the grinding of talc to the fine powder required by the trade presents no special difficulties, a great diversity of mill equipment and milling methods exists in the various talc-producing regions, and there appears to be little unanimity among talc grinders as to the best mill system. This is largely due to the difference in character of the talc of different regions, whether it is granular, massive, foliated, or fibrous. The individual prejudices of operators, doubtless, also plays a not inconsiderable part in the choice of grinding and sizing equipment.

The fact that there are no definite standards for powdered talc in the trade, and that relatively little is known regarding the role that many of the inert, mineral fillers, including talc, play in the various compounds in which they are used, and therefore of the characteristics that should be demanded in such materials, results in a decided lack of uniformity in the ground talcs on the market. The geographical relation of the consuming to the producing centres

[1] For a detailed description of the methods used in quarrying and dressing marble, reference may be had to The Technology of Marble Quarrying, by Oliver Bowles, Bull. No. 106, U.S. Bur. Mines, 1916.

is also a contributory factor to this diversity of products, since an industry will frequently use an inferior talc of local origin in preference to paying high transportation charges on a better grade that has to be brought from a distance.

The need for research into the physical and chemical properties of talcs, their true function in the various fields of industry in which they are used, and the determination of the most suitable grades and sizes for each use, is becoming more fully recognized by producers of ground talc. The Talc and Soapstone Producers' Association, formed in 1919 in the United States, has decided to initiate research on these problems, with a view to defining standards for talcs for different uses.

Ladoo (11) has summarized the various lines of research that might profitably be undertaken upon ground talc with the above object in view. These include both physical and chemical tests, of which the physical are the more important.

Physical tests. The physical properties suggested as subjects for investigation comprise: (1) size of grain; (2) shape of grain; (3) hardness; (4) colour; (5) slip; (6) specific gravity; (7) size, nature and percentage of grit; (8) absorptive power; (9) behaviour under heat. Other lines of attack would doubtless suggest themselves as work proceeded.

With respect to the above tests, Ladoo gives the following notes:—

(1) *Size of grain.* The importance of knowing accurately the average grain size is now generally recognized, although a few producers still make no sizing tests. The most efficient plants use a series of standard wire screens, ranging up to 200 mesh; and one uses a 300-mesh screen. As the approximate fineness of the talc to be tested is usually known, only one screen is customarily employed, although for accurate sizing of non-uniform material a series of screens is needed. The 200-mesh screen has been generally adopted as the governing screen for most finely ground talc. A definite quantity, 10 or 20 grams, is carefully weighed out and placed on the screen. Several methods of forcing the talc through the screen are in use. It may be shaken or jarred through, rubbed through with the fingers, or forced through by a fine water spray. The first method is the most common, but it is very slow for fine material; the second method, rubbing, is only useful as a rough, quick test; for the rubbing action not only wears out the screen, but stretches the wires apart, so that the sizing is not accurate. The water spray method is not generally known, but is one of the best methods in use. A nozzle, which will fit on an ordinary water faucet, designed to produce a very fine spray, is used. The screeen upon which the talc is placed is slowly passed under the spray, all the fine material being rapidly washed through. The screen is then placed on a warm plate or steam radiator to dry. When thoroughly dry the residue is brushed on to a paper and transferred to a balance pan for weighing. The spray method, although slightly slower than the shaking method, is less tedious and is very satisfactory. When screens are used, it is not sufficient to state merely the screen mesh when reporting tests, as different screen makers use different sizes of wire, with consequent differences in size of opening. To be strictly accurate, the size of the screen opening should be expressed in fractions of an inch or in millimeters. The adoption of a set of standard screens by the whole talc industry would be highly desirable.

The most accurate method of obtaining grain size is by actual measurement, with a microscope equipped with a micrometer eye piece. The average of a number of measurements gives a close approximation to the average size of particle. This method is not now used commercially, but is very useful.

(2) *Shape of grain.* No tests are now made commercially to determine the shape of talc grains, although this undoubtedly has a very important bearing upon uses. The predominant shape may be round or flat, needle-like or lath shaped, smooth or irregular. One grain shape may be best for paint, another for paper, and another for rubber. The determination of grain shape may be made readily with a microscope, and may have a very important application.

(3) *Hardness.* The hardness of crude talc is often roughly determined by scratching with the fingernail, a knife, or a coin, but no tests on the hardness or abrasive action of powdered talc are made. Hardness may be an important factor for some uses—for example, in lubricants and polishing agents, and as a filler for phonograph records; but no tests for the determination of the hardness of ground talc have been devised.

(4) *Colour.* A very pure white colour is insisted on by many customers of talc, but as yet no standard, accurate method of detecting slight differences in colour has been

devised. Practically all talc producers make a rough comparative test by the unaided eye, but the human equation enters very strongly into the results. Talcs are usually compared with a sample taken as a standard, but differing for each producer and consumer, the talc being either placed in little heaps or spread out flat with the finger or a knife, on the hand or on blue or white paper. Flattened heaps on blue paper in white light give the best results; but even this method is not satisfactory, as no standard samples are used in common by the whole industry, and difference in light and in the human equation produce varying results. The importance of accurate determination of slight colour differences is often great, for colour is not only an index of value, but also it is often an indicator of proper methods of grinding. Poor colour is not always due to impurities, but may be due to insufficient or improper grinding. In one instance a yellow colour in a talc was attributed to iron, but a microscopic examination proved that finer grinding would eliminate most of the objectionable colour. Finer grinding of many talcs improves the colour. A uniform and standard method for the determination of colour shoud be devised and adopted.

(5) *Slip.* Slip is a term applied to the relative smoothness or greasiness of ground talc. Good slip is desirable for some uses, and unimportant or even objectionable for others. Slip is ordinarily roughly determined by rubbing the talc between the fingers or in the palm of the hand. This test is very rough, and is of little value in the accurate comparison of talcs. A method of uniform testing of slip would be very desirable.

(6) *Specific gravity.* The specific gravity of pure crude talc varies from 2·55 to 2·78, but the apparent specific gravity of ground talc, as indicated by its behavior in water, oil or other liquids, varies between much wider limits. This is due to the facts (1) that other heavier minerals often occur with talc and are ground with it, (2) that grains of different shapes have different rates of settling in liquids, (3) that very finely ground talc has colloidal properties, which tend to keep it in suspension in liquids. Some paint manufacturers desire a heavy talc, which will sink in water, and others demand a flaky or fibrous talc, which has a tendency to stay in suspension and not cake down solidly. Some of these differences are due to differences in specific gravity, and some to shape and size of grain, surface tension, etc. It would be very desirable, therefore, to devise uniform methods of determining not only the specific gravity, but also the other properties that affect the behavior of talc, both as a dry filler and in liquids. No such tests are now in use.

(7) *Grit: size, nature and percentage of oversize.* The presence of grit or oversize in ground talc is objectionable for most uses. Sometimes the grit is a siliceous or other impurity, and sometimes it is merely insufficiently ground talc. In some products siliceous impurities would be very harmful, whereas oversize talc would not be objectionable; for example, in lubricants. In other products, oversize of any nature and siliceous impurities, even if finely ground, would be injurious; for example, in paper manufacture. It is, therefore, important to know the size, nature and amount of grit or oversize present in ground talc. The screen tests, previously described, may be used to determine the amount of oversize, but the nature and size can only be determined under a microscope. If the grit is siliceous, and not oversize talc, its presence can be detected by "gritting" between the teeth, or by rubbing between the finger nails. This method is a crude one, and does not determine the nature, size, nor relative amount present. Another method in use is to flatten out a small pile of talc, so as to present a smooth surface, by pressing or rubbing with a piece of plate glass. This method will detect only coarse impurities present at, or close to the surface of the pile. There is, then, no test or series of tests now in use which enables accurate and uniform determinations of this property to be made. A careful microscopic examination is of great assistance, but is not wholly satisfactory for this purpose.

(8) *Absorptive power.* The absorptive power of ground talcs is a property which has never been determined commercially, but in many uses of talc it is probably of greater importance than has been suspected. In the manufacture of paints, the oil absorption of the various paint materials is of great importance, but even for this use talc producers do not determine the absorption. It is probable that when talc is used in the manufacture of paper, the absorptive power of talc has an important effect upon retention. When talc is used as a deodorant, a decolorizer, or a degreasing agent, it is certain that absorptive power is very important. It is possible that the oil absorption test of the paint chemist might be used to determine the absorptive power of talc in general for various uses. But this subject is not well understood and is worthy of careful consideration.

(9) *Behavior under heat.* Massive talc and soapstone have long been used as both heat-resisting and heat-retaining agents, and ground talc has been used in pipe-covering compounds and fireproof paint. The last use is growing in importance, and the value of talc as a fireproofing material is becoming better known. When used as a ceramic material, in the production of china and porcelain, its behaviour under high heat is of great importance. Some talcs contain mechanically combined water, others contain lime, dolomite, iron, or other impurities which may alter the colour, destroy the slip, or cause the talc to swell under heat. Pure talcs vary in melting point, and in behavior under high heat in ceramic compounds. Standard and uniform tests for the behavior of talc under heat should be devised.

Chemical tests. The most common mineral impurities in commercial powdered talcs are dolomite, calcite, magnesite, quartz, pyrites, and such silicates as tremolite, chlorite, and serpentine. For certain uses, little or no objection is raised to the presence of such impurities, within limits, but for many purposes, several or all of them are objectionable. Quartz and fresh, unaltered silicates, as well as pyrites and the harder carbonates, form grit, which is decidedly harmful in the finer grades of talc. Iron-bearing minerals, particularly iron oxide, injure the colour, and spoil talc for many purposes. Carbonates are not generally held to be objectionable, though their presence in excess reduces the slip. Some paper chemists object to lime on the ground that it causes foaming, and exerts a harmful effect on the sulphate solution.

As will be noted from the tables of analyses of talcs in Chapter I, few of the talcs examined approximated at all closely to the theoretical composition of pure talc. While a complete chemical analysis of talc is a lengthy operation, and is usually not necessary in commercial practice, simple chemical tests for soluble iron and carbonates are useful, and generally suffice to enable the quality of the talc to be gauged fairly closely.

TALC MILLING

In the accompanying flow sheets (see also pp. 28, 30, 32, 63, 64, 65, 66, 67, 68, 69), are indicated the various systems of milling talc employed in American and Canadian talc mills. It will be noted that there is considerable diversity in the grinding and sizing equipment used. All milling of talc on the American continent is conducted dry.

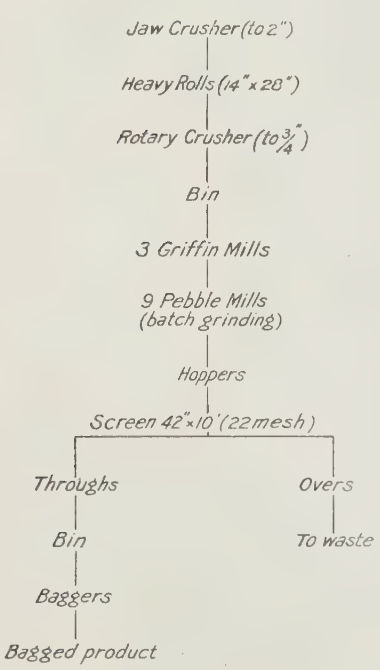

Fig. 7. Flow sheet of mill system at No. 3 mill of International Pulp Company, Gouverneur, New York. (After Ladoo.)

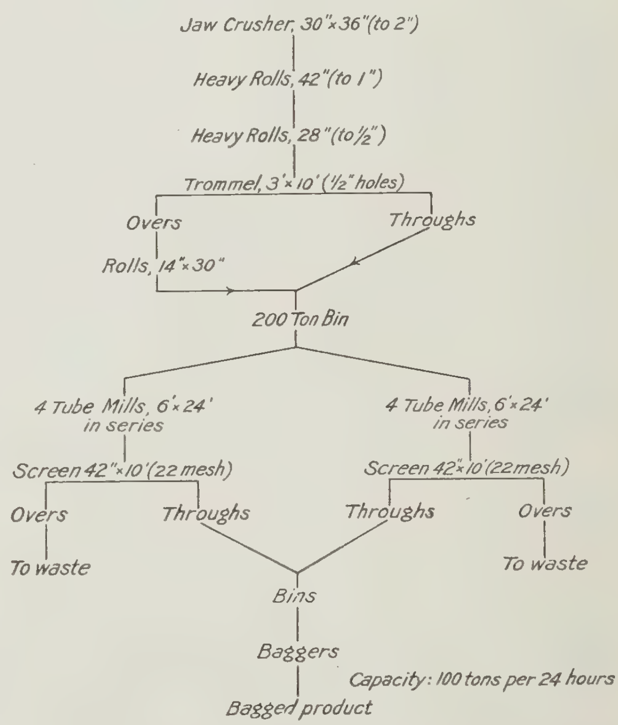

Fig. 8. Flow sheet showing general mill system at No. 6 mill of International Pulp Company, Gouverneur, New York. (After Ladoo.)

Drying. Some talc mills are equipped with dryers, to effect a preliminary drying of the crushed ore or of the run-of-mine fines before they proceed to

the fine grinders. Operators differ as to the expediency of using such dryers Often the crude, lump talc from the mines is sufficiently dry to undergo grinding without difficulty. The fines, however, tend to absorb and hold moisture. At some mills, the run-of-mine ore is dumped over a grizzly, the lump talc going direct to the coarse crushers, while the fines are subjected to a preliminary drying. The dried fines then join the discharge from the crushers, and both proceed through the mill. An alternative method is to run the mill on lump talc until there is an accumulation of wet fines; the latter are then run through separately.

In Vermont and Ontario mills, the usual practice is to subject the crude fines, or the coarsely crushed talc, to a preliminary drying. New York and Californian mills do not dry their mill feed.

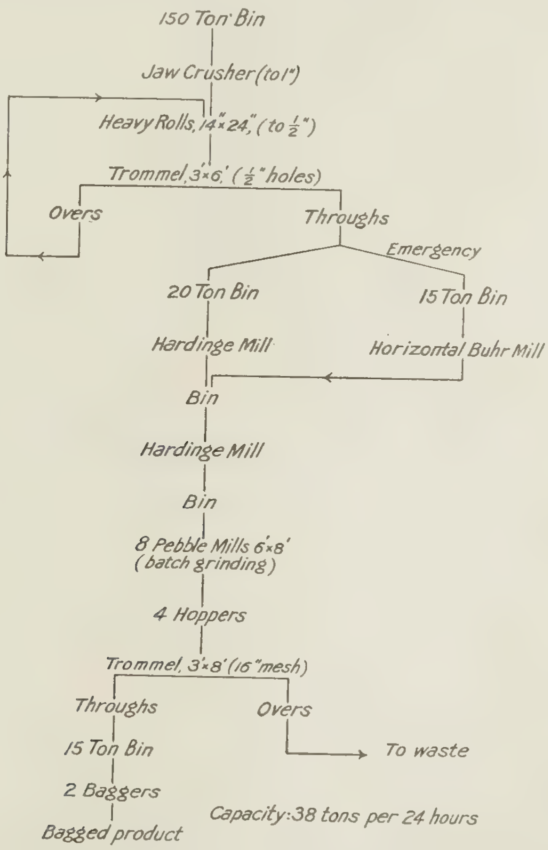

Fig. 9. Flow sheet of mill system at mill of Uniform Fibrous Talc Company. Talcville, New York. (After Ladoo.)

The following notes on the drying of talc are taken from a report by R. B. Ladoo (1):—

The problem of wet fines is handled in several different ways in the Vermont district. At one mine, all material from underground is hoisted in a skip and dumped automatically over a two-inch grizzly, set at a low angle. The wet fines fall into one bin, and the coarse, after being picked, is spouted in another bin. The dry talc and the wet are hauled in separate cars to the mill, and there dumped into separate bins. Talc, from the dry bins, passes directly to a jaw crusher, while that from the wet bins goes first to either a Bartlett and Snow, or a Ruggles-Cole dryer. The inner drum of the Ruggles-Cole dryer has been removed, making it a direct heat instead of indirect. Coke is used as a fuel, so that the talc is not discoloured by smoke and soot. From the dryers, the talc joins the discharge from the jaw crusher.

At another mine, the wet fines are screened out at the top of the shaft, and dumped on wet stock piles. As the surface of the piles dries out, the top material is shovelled off and hauled to the mill. At the mill, it is stored in long, low piles under sheds, until it is dry enough to grind.

At a third mine, a separation of wet and dry material is attempted underground. In mining the talc, raises are put up along the steeply dipping walls at the intervals of about 50 feet along the drifts. These raises are widened out into stopes, and may be connected with each other by branched raises. Grizzlies, made of wooden poles, are often placed at the junction between two branched raises. These grizzlies have about 2 inches openings, and are arranged so as to divert the coarse material to one chute, and the wet fines to another. In drifting, the large pieces are loaded separately from the fines. In this way the dry rock and the wet are hauled separately to the mill, and dumped in separate bins. The mill (see flow sheet, Fig. 13) is ordinarily run on the coarse, dry material, but when a bin full of wet fines has accumulated the dry feed is cut off, and the wet is run through separately. The dry and wet processes are alike in the initial and final stages, but differ in the intermediate stage. The crude talc is con-

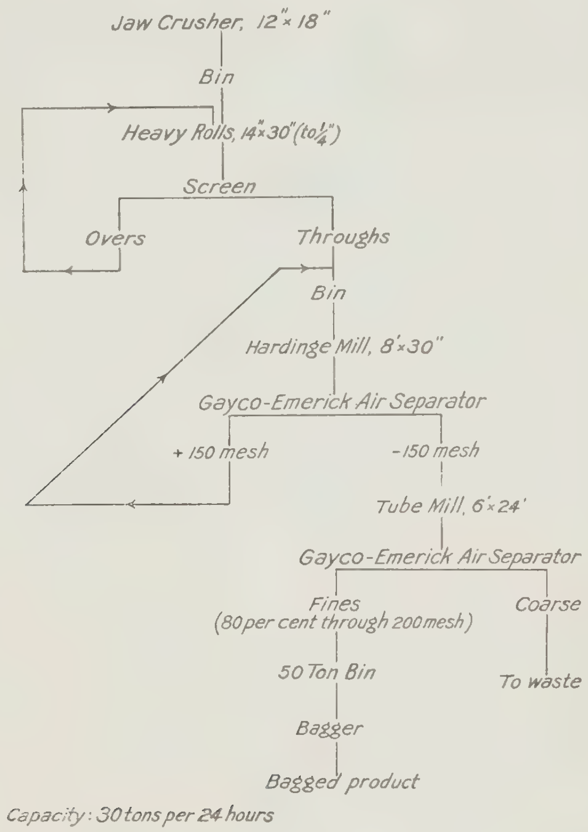

Fig. 10. Flow sheet of mill system at mill of W. H. Loomis Talc Corporation, Emeryville, New York. (After Ladoo.)

veyed from the bins to a jaw crusher and then elevated to a rotary screen with ½" round holes. The oversize (either wet or dry) goes to a Sturtevant rotary crusher, thence, if dry, to stock bins, if wet, to a Ruggles-Cole dryer. The screen undersize, if dry, goes to the stock bins, but if wet, it goes to the dryer. The dried material in either case joins the dry crushed rock in the stock bins. The Ruggles-Cole dryer is of the indirect heat type, and is fired with bituminous coal.

At a fourth mill, no mechanical dryer or other means of drying is used. Great care is used underground in keeping the talc rock dry while mining, and in preventing water from entering muck piles. Two-inch planks are laid down close together in the drifts, raises, and stopes before each shot is fired. By this means not only are water and iron stain from rails and pipes largely excluded, but shovelling is made much easier. Some wet material inevitably reaches the mill, but through mixture with dry rock, it does little harm.

In all of the examples cited, the talc is subsequently ground by emery mills, pulverizers, or roller mills, equipped with the Raymond system of air separation. The problem of drying here is thus somewhat different from that at mills which use tube mills.

The advantages of grinding only dry stock are evident and cannot be denied, for wet material packs badly in bins, crushers, and grinders, reducing capacity, increasing labour charges, makes efficient air separation more difficult, and may lower the grade of the finished product. The economy of using a dryer, or air drying in heaps, is not so evident. Screening and drying at the mine are expensive, slow, and inefficient, for the material

must all be rehandled by hand several times. The drying is not uniform through the heap, and is very slow in rainy or cold weather. The advisability of using a mechanical dryer depends upon the following factors:—

1. Ratio of wet to dry material as mined.
2. Percentage of moisture in wet material.
3. Cost and feasibility of excluding moisture underground.
4. Mill capacity.
5. Cost of drying.

If the proportion of wet to dry material is very small, or if the average percentage of water in the wet material is small, then it may be found possible to eliminate any form of drying, by mixing the wet and dry together before crushing. If the walls and roof underground are seamy, and water constantly drips from the roof, the use of planks for shovelling may not exclude the moisture, and no feasible method of keeping the rock dry underground may be found. If planks or other means can be devised to keep the talc dry, then the cost of such protection must be balanced against the advantages gained, and against the cost of mechanical drying. A very small mill capacity may preclude the

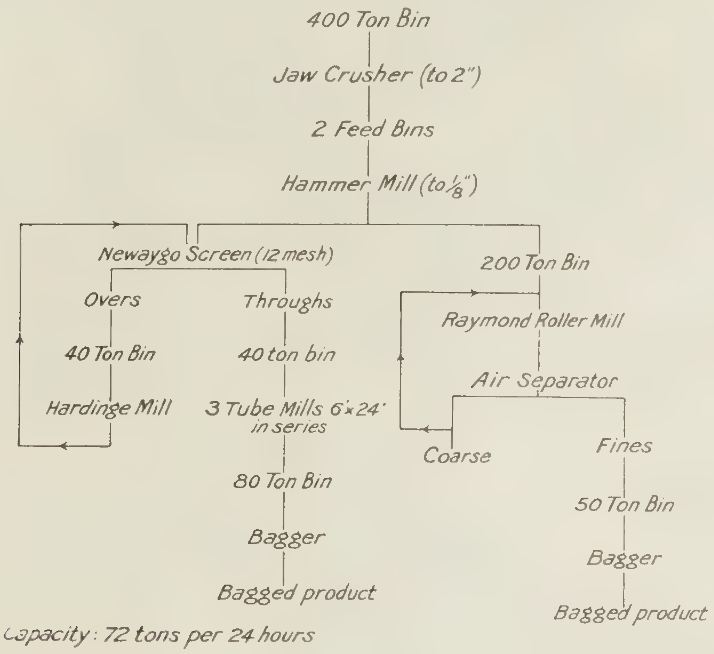

Fig. 11. Flow sheet of mill system at mill of St. Lawrence Talc Company, Natural Bridge, New York. (After Ladoo.)

possibility of advantageously installing a dryer, irrespective of other factors. The cost of drying may be so low that the exclusion of moisture underground may not be worth while. In general, however, the cost of drying is an important, if not large item.

The ideal method of handling wet fines would probably combine the best features of each of the examples cited. In a mine where the exclusion of moisture underground is feasible, the use of planks is advised, for this method obviates drying and increases shovelling efficiency. For the elimination of a small amount of moisture, mixing may be advisable. Mixing of crude stock will also increase uniformity of feed and of finished product, but has the disadvantage of making difficult the preparation of special grades from small lots of high grade crude talc.

With proper precautions, it seems probable that most mills could dispense with the use of dryers. It would be worth while, however, in large mills to have a small dryer in reserve, so that the mill would not be held up if, for some reason, it became necessary to handle small tonnages of wet stock. In conjunction with the reserve dryer, it is well to consider the installation of sufficient auxiliary machinery to enable the milling of wet and dry stock simultaneously, instead of running dry and wet alternately. The relative economy of using a direct heat dryer, fired with coke, compared to the use of an indirect heat dryer with coal is worthy of study. Here, the difference between the cost of coal and coke must be balanced against the increased fuel efficiency of coke and of directly applied heat, the freedom from smoke and soot, and the possibility of recovering fine talc carried out of the heater by forced draft.

One Ontario mill uses no dryer, and two dry the coarse talc from the crushers in Cutler, revolving, steam pipe dryers (see p. 29).

Coarse crushing. Jaw crushers, rotary crushers, heavy rolls, and hammer mills are commonly used to effect the initial reduction of talc.

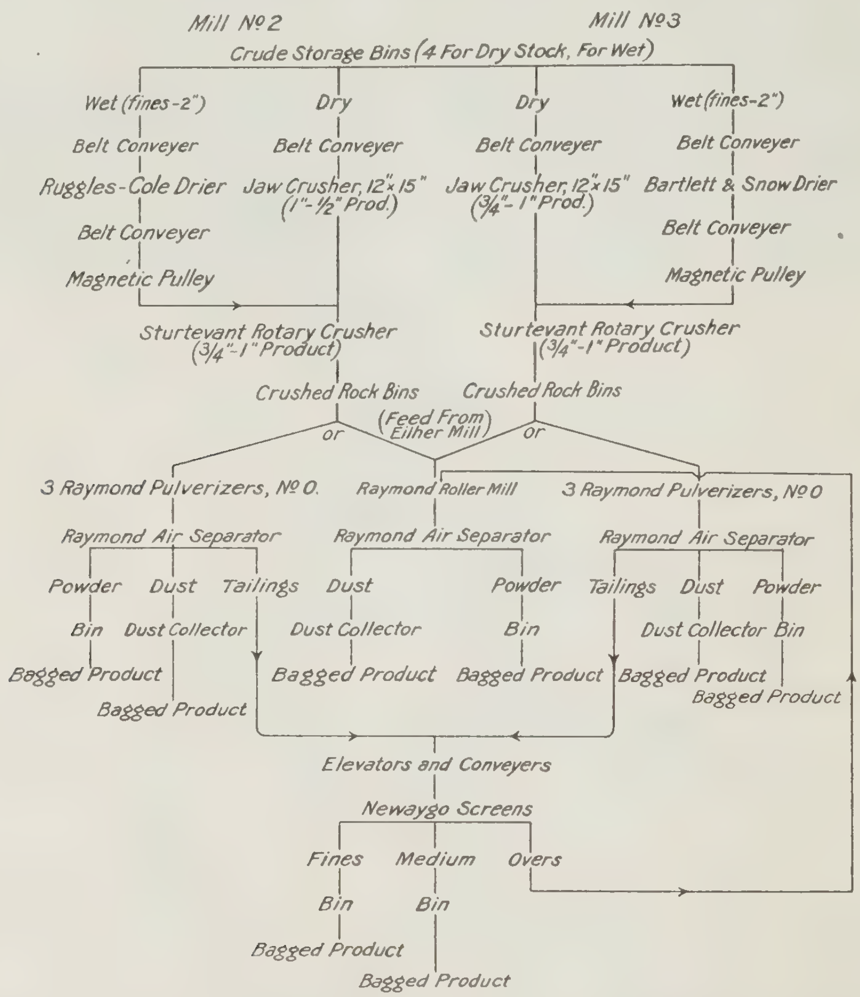

Fig. 12. Flow sheet of mills No. 2 and No. 3, Eastern Talc Company, Rochester, Vermont.

Fine grinding. The fine grinding equipment is of various types. In recent years, tube mills have come largely to the front for this purpose. These mills are lined with silex or porcelain brick, and flint pebbles are used for grinding. The mills are usually of the continuous feed and discharge type, and are run either in conjunction with some type of air separator or with screens. The mills used vary from the single 5 x 8-foot cylinders, in more common use, to the large 6 x 24-foot cylinders arranged in series, four mills to a set, in some New York mills. Hardinge mills are also used to some extent, and a few mills practise batch grinding in short tube mills.

Raymond roller mills, equipped with Raymond air separators, are favoured by Vermont operators. It is claimed that these mills exert no selective action, but reduce equally the whole of the feed, both hard and soft particles, thus achieving uniform products in the different mesh sizes. The pebble mills, on the contrary, are supposed to permit the passage of a considerable proportion of coarse grit, thus effecting a lower grade of talc in the coarser sizes.

Sturtevant pulverizers, equipped with air separation, Griffin mills, Fuller-Lehigh pulverizers, and burrstones are also in use. Some years ago, emery burr mills were in almost universal use in Canadian talc mills, but they have now been largely discarded in favour of tube mills. In some cases a combination of two or more of the above types of grinding machines is used in the same mill.

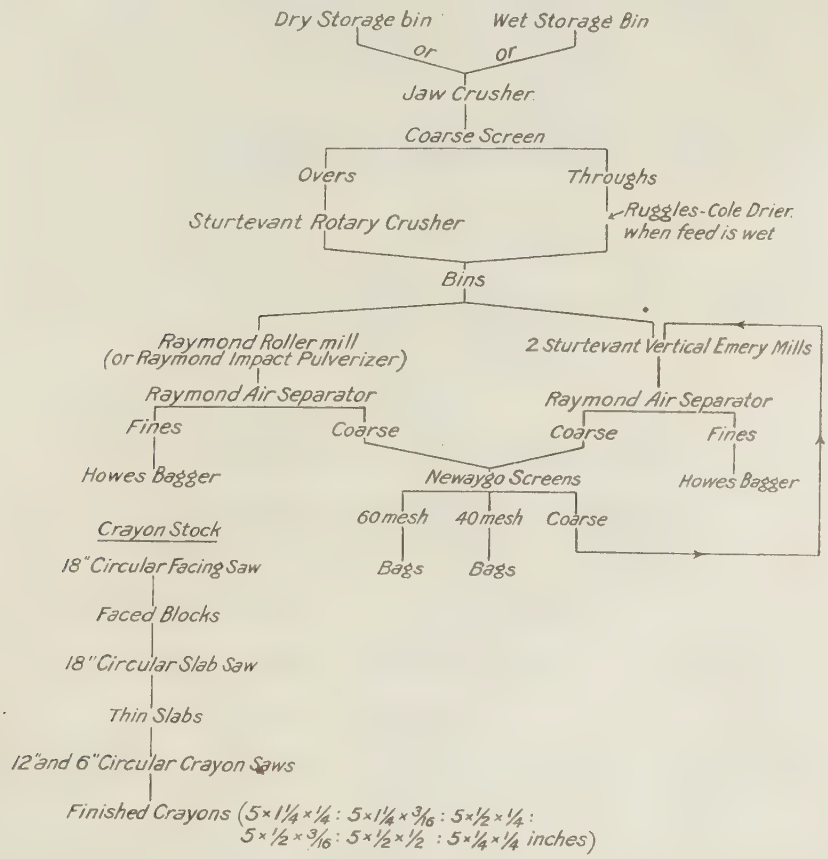

Fig. 13. Flow sheet of mill of Magnesia Talc Company, Waterbury, Vermont.

Screening and sizing. Sizing of the finely ground talc is effected by air separators, Newaygo or other type of impact screens, or silk bolters. Air separators of one type or another are applicable to all types of talc, but the choice of screening and bolting devices depends on the softness, shape of particles, and amount of grit present.

Batch grinding in intermittent tube mills, while possibly not economical, dispenses with sizing, and the ground product is merely passed through a coarse screen to remove wood or other extraneous material. The same holds good for the grinding in long tube mills in series, as practised in the Gouverneur district, New York. In one New York mill the feed takes four hours to pass through the four tube mills. This system requires the expenditure of considerably more power than is necessary for batch grinding.

Air separation devices are of varied types. The Raymond and Sturtevant mills are equipped each with its own type of separator. In one New York mill, Gayco-Emerick air separators are used, run in conjunction with Hardinge mills. Some mills use an improvised system, consisting of a blower connected with the pebble mill or other type of fine grinder, and discharging into a series

of cheesecloth dust chambers. These chambers yield progressively finer sizes of talc with increasing distance from the blower discharge. The objection to this system is the space required, and the amount of dust escaping into the mill.

The mill of Geo. H. Gillespie and Company, at Madoc, Ontario (see flow-sheet p. 28), is unique in being equipped throughout with silk bolters. These are of the flour mill type, hexagonal, reel scalpers, fitted with silk bolting cloth, and are run in closed circuit with 5 x 8-foot tube mills. These bolters screen successfully down to 180-mesh product. It is claimed that they do not suffer excessive wear, and this is probably due to the softness of the talc from the Henderson mine and its freedom from gritty minerals.

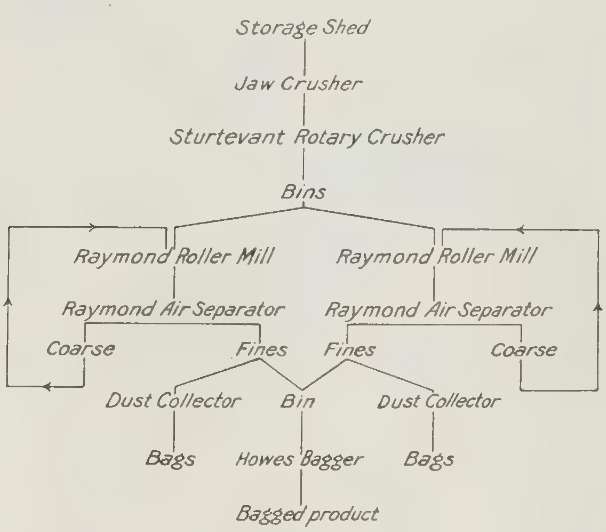

Fig. 14. Flow sheet of mill of Vermont Talc Company, Chester, Vermont. (After Ladoo.)

Bagging. Finished talc may be conveyed either to large storage bins, holding, perhaps, a day's output, or direct to bagging hoppers. Some operators favour one system, and some the other. Storage bins facilitate the use of bagging machines, enable the bagging of a day's run to be done in one shift, and obviate delays due to break-downs in either the grinding or bagging department. Objections to the use of storage bins are that grades cannot be readily changed without emptying the bins and that accidental contamination of a bin of ground talc may readily occur. The use of spare bins, and a reasonably close check on the talc entering the storage bins, would overcome these objections. All things considered, the use of storage bins, when proper control is exercised, makes for efficient operation.

The flow sheets of New York talc mills given here are taken from a report by R. B. Ladoo, Talc Mining in New York, issued by the United States Bureau of Mines (14). The flow sheets of Vermont mills are taken from a report by the same author, Talc Mining in Vermont, also issued by the Bureau of Mines (4).

In 1917 California became an important producer of talc. This talc is generally of a very high grade, and is suitable for toilet powders and other purposes demanding an exceptionally good grade of talc. The distance of the mines from rail, and the heavy freight on the milled talc to eastern markets, may prevent the Californian talc from competing with imported high grade

talc in the latter field. Ladoo (17) gives the following flow-sheet of a Californian talc mill. In this case, a proportion of sound, massive talc, suitable for cutting into cores for heating elements, is obtained, and this material is handled as indicated in Fig. 15. Another Californian talc mill uses a 5-roller, high-side Raymond mill, equipped with the Raymond system of air separation, for fine grinding.

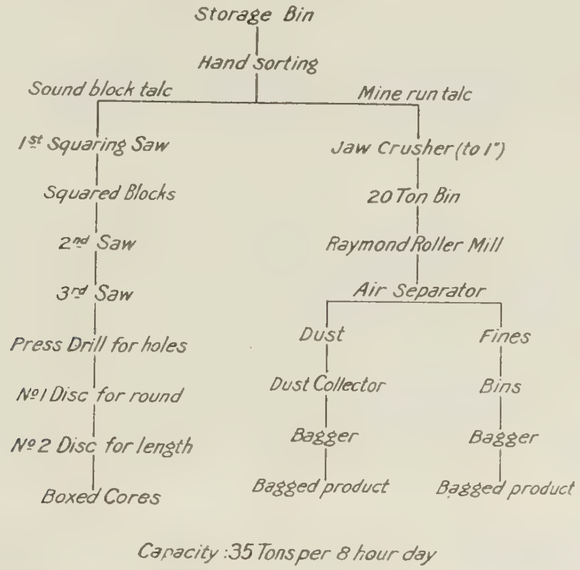

Fig. 15. Flow sheet of mill of Inyo Talc Company, Keeler, California. (After Ladoo.)

MILLING COSTS

The following notes on the cost of production of ground talc in Canada are given[1] by Mr. Geo. H. Gillespie, of Geo. H. Gillespie Company, Ltd., Madoc, Ontario, the largest Canadian talc producers:—

The average cost of producing a ton of Canadian talc during 1920 was $12, not including taxes and depreciation on plant. It should be noted that Canadian costs are high. Plant and machinery costs more than in the United States, as machinery is largely imported from the United States and has to pay duty on entry into Canada, while the severe Canadian climate adds to the cost of production.

The values of our grades of talc exported to the United States, as set by a representative of the United States Treasury Department, for the year 1920, were as follows:—

Grade AA1—F: $22 per ton, including bags f.o.b. Madoc.
Grade 1: $16.50 per ton, including bags f.o.b. Madoc.
Grade S: $12 per ton, including bags f.o.b. Madoc.
Our annual production is: Grade AA1—F: 8,000 tons.
Grade 1: 4,000 tons.
Grade S: 2,000 tons.

Asbestiform (New York) and Vermont talc are exported to Canada from the United States, and are sold at such low prices that Canadian production would be impossible against this competition.

Massive Talc

Massive talc, or steatite, is the most valuable form of talc. The chief qualities desired[2] in a massive talc that will be suitable for machining into blanks for lava or other purposes are fineness of grain, compactness, softness, freedom from cleavage and flaws, absence of grit, and low iron content.

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1 Tariff Information, 1921, Hearings of General Tariff Revision, Committee of Ways and Means, U.S. House of Representatives, Part I, p. 368.

2 Tariff Information, 1921, Hearings on General Tariff Revision, Committee of Ways and Means, U.S. House of Representatives, Part I, p. 365.

The valuable properties of finished massive talc are great hardness and tenacity, resistance to heat, acids and alkalies, high compressive and dielectric strengths. No other mineral can be shaped into articles in the raw state, which, when hardened in the furnace, will retain their shape perfectly. Massive talc is indispensable for the manufacture of gas tips, gas burners, bushings for gasoline engines, electrical insulation, and many other purposes.

Massive talc is mined or quarried in large blocks, which are then cut into smaller blocks by man power, using crosscut saws. These smaller blocks are then cut by means of rip or cutoff saws into cubes or blanks of specified shape and dimensions. The sizes commonly range from $\frac{1}{4}$ x $\frac{1}{4}$ x $\frac{1}{2}$ inch to cubes measuring 3 and 4 inches.

These blanks are placed one at a time in small, high-speed lathes, in which they are turned, drilled, slotted, and threaded, as the case may be. The green, finished articles are then placed in small gas or electric ovens, where they are subjected to a temperature of about 2000°F. for from 24 to 48 hours. After firing, the material is termed lava, and possesses great hardness.

During firing, there is practically no expansion or contraction, and standard threads cut in the green talc are still standard after baking.

CHAPTER IV

TALC IN FOREIGN COUNTRIES

Talc and soapstone are quite widely distributed substances, and deposits are known in very many countries. The most important producing countries,[1] with their percentage of the world's total output, are: United States, 65 per cent; France, 13 per cent; Italy, 7 per cent; Germany and Austria, 5 per cent; Canada, 5 per cent

Soapstone is obtained chiefly from the United States, the quarries in Virginia having a virtual monopoly of slab and block soapstone.

The greater part of the ground talc produced is of the lower grades, used in the manufacture of paper, rubber, paint, roofing, etc. The highest grade talcs are those used for the toilet powder and cosmetics trade, and the pure massive talc, or steatite, used for the manufacture of lava.

According to a report issued by the Imperial Mineral Resources Bureau,[2] the production of talc (including soapstone) of the principal countries, from 1913 to 1919, was as under:—

World's Production of Talc (in long tons)

—	1913	1914	1915	1916	1917	1918	1919
United Kingdom	40	180	850	301	1,233	936	688
Union of South Africa	....	....	39	118	746	652	788
Canada	10,937	9,650	10,612	11,700	14,110	16,222	16,645
India	2,524	999	1,077	1,214	7,829	12,983	2,040
Australia	104	80	60	387	234	619	622*
Austria (exports)	7,953	6,093	5,883	5,668	3,866	....	....
France	59,208	....	....	....	....	56,660	....
Bavaria	....	1,707	1,814	1,867	2,136	9,158	....
Italy	44,622	41,343	45,135	52,557	41,989	34,910	34,176
Norway (exports)	2,392	3,147	3,355	6,282	2,896	....	....
Spain	4,336	4,538	948	3,504	3,395	3,275	2,975
United States	156,994	153,836	166,867	190,144	195,400	185,988	168,000

*Provisional figure.

Canada and India are the chief talc producers within the Empire. In 1915 South Africa entered the list of producing countries, and important deposits have been proved to exist in the Transvaal. The Indian output is chiefly steatite, obtained from the Jubbulpore district, Central Provinces.

Below are given brief notes on the talc industry in the principal producing countries. This information has been taken mainly from the following publications: Imperial Mineral Resources Bureau, Report on Talc, 1921; Mineral Industry, Annual Volumes; Reports of the United States Bureau of Mines and of the United States Geological Survey.

1 Ladoo, R. B., U.S. Bur. Mines, Reports of Investigations, (5) October, 1919.

2 Mineral Industry of the British Empire and Foreign Countries, Talc, 1921.

Australia

Large amounts of ferruginous talc occur near Wallendbeen, Murrumburrah mining division, New South Wales. Only a small production is recorded from this occurrence.

In South Australia, small amounts of talc have been mined at Talunga. High grade talc has been obtained in small quantities from the Yaranyacka mine, near Lipson.

In Victoria, talc is found in the Heathcote mining division.

The total Australian production of talc in 1919 is given as 622 long tons.

Austria

Most of the Austrian talc is derived from Styria, the deposits being located in the communes of Mautern, Aflenz, Anger, Pöllau, St. Kathrein and Floing. A large proportion of the talc produced finds a market in the German paper industry. The production in 1917 is estimated at 13,000 tons.

France

The principal talc-producing region of France lies in the Département of Ariège, which produces 85 per cent of the total French output. The most important deposits are situated at Montferrier, in the Pyrenées, about twelve miles from the Spanish frontier.

Other localities include Luzech, in the Département of Lot, and various places in the Départements of Pyrenées-Orientales, Isère, Aude, Savoie and Loire. The Luzech talc is of a bluish-white colour. There is also a small production from the island of Corsica.

The exports of talc in 1919 totalled 9,464 long tons, valued at about $200,000.

Germany

Almost all the talc mined in Germany is derived from the well known deposits at Göpfersgrün, near Wunsiedel, in Bavaria. The talc is of the massive, or steatitic variety. The production of talc in Bavaria in 1918 is given as 9,158 long tons.

India

There was a production of nearly 13,000 long tons of talc in India in 1918, valued at $53,185. In 1919, however, the output fell to a little over 2,000 tons.

Production is chiefly derived from the region around Jubbulpore, in the Central Provinces, where considerable quantities of steatite occur in a limestone formation. A grinding mill to handle the output of this district has been erected at Jubbulpore.

Steatite is also mined in Bihar, Orissa, Madras, and the United Provinces. At Dogetha and Morra, in Rajputana, large deposits of high grade steatite occur, and this material is quarried for the manufacture of ornamental carvings.

Indian steatite is very suitable for the manufacture of lava, and a considerable portion of the talc used for this purpose is obtained from India.

Italy

The principal talc-producing region of Italy[1] is in the Valle di Chisone, near Perosa, and near Pinerolo, south of Turin, in Piedmont. The output of ground talc would appear to be derived from one or two mills that draw their supply of crude talc from a number of small quarries. The Italian talc is pure white and of very high grade. It is in demand for talcum powder and cosmetics and for polishing rice. Massive talc is also produced.

The production of crude talc in 1919 is given as 17,268 long tons, valued at nearly $450,000. The output of ground talc in the same year was 16,908 long tons, valued at $686,000.

Italian talc is produced under difficulties, owing to the high elevation at which the mines are located and lack of transportation facilities. Work has usually to be suspended during the winter months. The wholesale price of Italian talc in the American market in 1920 was about $50 per ton, or about $15 per ton more than the best domestic talc.

Newfoundland

At Talc Mountain and at Fox Trap, near Manuels, Conception bay, extensive deposits of pyrophyllite occur and have been worked on a considerable scale. This material is commonly classed as talc.

Norway

Talc is produced in the provinces of North and South Bergenhus, the principal mills being located at Sognefjord, north of Bergen, and near Vikor, southeast of Bergen.

Soapstone is mined at Gudbrandsdal.

Exports of talc and steatite from Norway in 1917 totalled 2,896 tons, valued at $43,596.

South Africa

South Africa[2] produces a small amount of talc, the output in 1920 being given as 682 tons. The principal talc deposits lie in the Barberton district, in the Transvaal. Two mines in this district are stated to have capacities of 200 tons and 500 tons of talc per month, respectively. Deposits are also stated to occur in Southern Rhodesia and in Zululand.

At the Verdite mine, in the Barberton district, which is one of the most important producing mines, gold occurs with the talc and is recovered during the milling process.

Spain

Talc of good quality is found in the province of Almeria, 45 miles from the port of Aguilas, where deposits yielding talc comparable to the best Italian grades are stated to occur.

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[1]Peck, F. B., Mineral Industry, Vol. XXVI, 1917, p. 673. Oil, Paint and Drug Reporter, Vol. 101, No. 14, March 28, 1922, p. 85.

[2] See Wagner, P. A., South Africa Journal of Industries, June, 1918, pp. 903-9; Trevor, T. G., South African Journal of Industries, 1920, III, p. 534.

Most of the Spanish production is secured from mines north of Figueras, province of Genoa, on the south side of the Pyrenées.

The Spanish production of talc in 1919 amounted to 2,975 long tons.

United States

The marketed production[1] of talc and soapstone in the United States in 1920 amounted to 224,290 short tons, valued at $3,090,265.

Vermont was the chief producing state, with a tonnage of over 86,489 tons, valued at $816,794. New York came second, with an output of nearly 70,000 tons.

The price average increased 15 per cent, and demand was good, the greater part of the production being absorbed by the paper, roofing, paint, rubber, and textile industries.

There was an increase in the production of soapstone in 1920, the output being given as 19,707 short tons, valued at $709,400, an increase over 1919 of 16 per cent in quantity and 25 per cent in value.

The table below shows the production of talc and soapstone in the United States for the five-year period 1916-20:—

Talc and Soapstone produced in the United States, 1916-1920
(In short tons)

Year	Crude		Sawed and manufactured				Ground		Total	
			Talc		Soapstone					
	tons	$	tons	$	tons	$	tons	$	tons	$
1916........	11,824	108,283	828	102,674	19,127	489,606	181,182	1,553,240	212,961	2,253,803
1917........	12,619	69,140	5,781	176,404	19,885	402,506	180,563	1,644,828	218,848	2,292,878
1918........	17,633	193,278	1,075	116,952	12,330	501,059	177,269	1,869,730	208,307	2,681,019
1919........	15,625	73,437	921	147,339	16,504	530,163	151,793	1,601,736	184,843	2,352,675
1920........	24,663	98,636	1,415	139,335	19,707	709,400	178,505	2,142,894	224,290	3,090,265

The production of talc and soapstone by States in 1920 was as follows:—

Production of Talc and Soapstone by States, 1920

—	Short tons	$	Per cent of total quantity
Vermont..........	86,489	816,794	39
New York..........	68,168	977,228	30
Virginia..........	21,715	729,767	10
Maryland..........	18,027	72,764	8
California..........	13,199	232,182	6
Pennsylvania.......... New Jersey..........	11,183	121,302	5
North Carolina..........	2,267	75,474	1
Other States..........	3,242	64,754	1
Total..........	224,290	3,090,265	100

[1] Sampson, E., U.S. Geol. Surv., Mineral Resources, 1920, Part II, pp. 201-13.

The average selling price per ton of ground talc, and of sawed and manufactured soapstone, in 1920, was, respectively, $12 and $36.

California. The California talc is of high grade, and much of it is used for toilet powder. The more massive talc finds use in the manufacture of cores for heating elements.

Georgia. A great part of the talc mined in Georgia finds employment in crayons.

Maryland. Three companies mined talc in Maryland in 1920. The deposits are situated near Conowingo, near the Pennsylvania border, and are derived from basic igneous rocks. Some of the Maryland talc is massive and refractory enough to be used for lava purposes, and it is stated that the quality is improving with depth.

New York. Most of the New York talc is of the so-called fibrous variety (asbestine or agalite), and is consumed chiefly in the paper, paint, and rubber trades. It is of a fine white colour, but possesses little slip.

North Carolina. North Carolina produces both talc and pyrophyllite, the latter being marketed as talc. Pencils and crayons consume an important part of the output.

Pennsylvania. The Pennsylvania-New Jersey production comes from both sides of the Delaware river, near Easton. The output in 1920 was the largest in the history of the field, and consisted entirely of ground talc.

Vermont. Most of the Vermont talc is marketed in the ground state. One company produces a small quantity of crayons and pencils. There was formerly a small production of slab and block soapstone from this state, but the output of this class of material has now practically ceased.

Virginia. The output of Virginia consists of both low-grade ground talc (soapstone), suitable for foundry facings, roofing, etc., and sawed and manufactured soapstone. This state furnishes practically all of the soapstone produced on the American continent, and the output is estimated to exceed considerably the combined output of all other countries. The production in 1916 totalled 20,000 tons, and the same figure was reported in 1917. Of the 1916 total, over 15,000 tons consisted of manufactured articles, such as griddles, fire ends, bricks, etc., with an average value of nearly $27 per ton; 3,500 tons were marketed as slabs for laundry tubs, table tops, panels, etc., with a value of $20 per ton; and 500 tons were sold as crude stone, at an average price of $2.50 per ton. In 1918 the output was nearly 17,000 tons, valued at $591,000.

The Virginia soapstone forms a large belt, extending through Nelson, Albemarle, and Orange counties. It is regarded as an altered pyroxenite or peridotite, the pyroxene and olivine of which have undergone various degrees of alteration, and are found sometimes as serpentine and sometimes as talc. Stone of various degrees of hardness is encountered in the workings, the hardest stone containing much residual pyroxene.

The producers of sawed and manufactured soapstone are the Virginia Alberene Corporation (Alberene Stone Company), with quarries at Schuyler, Nelson county, and Oliver Bros., Incorporated, who mine at Arrington, also in Nelson county.

Other Countries

Brazil. Brazil is known to possess deposits of high grade talc and soapstone, but the production is small. White talc is mined at Rezende, state of Rio de Janeiro; at Lorena, state of Sao Paulo; Santo Amaro, state of Bahia; and also in the state of Goyaz. A small amount of massive talc is worked by natives in the states of Bahia, Minas Geraes, and Ceara.

China. China is stated to possess important deposits of talc and soapstone. Most of the production comes from the Tsintien region, Chekiang province, and from the provinces of Chi-li and Fukien. The greater part of the production consists of massive talc, or steatite, which is carved into ornaments, images, and utensils of various kinds.

According to Ladoo (9), talc of very fine grade occurs near the town of Tashih Chiao, South Manchuria. The deposit lies 4 miles east of the town, which is on the main line of the South Manchurian railway, 148 miles from Dairen, 233 miles south of Mukden, and connected with Newchang by a branch line 14 miles long. The talc is of the massive or steatitic variety, fine-grained and massive, of a cream colour and generally of excellent quality. The powdered talc is stated to be equal, if not superior, to the best Italian talc.

United Kingdom. The United Kingdom produces a small amount of talc, and there was a production of 688 tons, valued at about $5,000, in 1919. The most important deposits, from an economic standpoint, would appear to be those in Donegal, Mayo, and Wicklow counties, in Ireland. The Donegal deposits are the only ones that have been worked continuously in recent years.

Uruguay. Uruguay produces a small amount of talc, which is obtained near Las Conchillas, in Colonia. The chief market for this material is in Buenos Aires and Montevideo, where it is used in the paper and toilet powder trades.

Other countries. Talc is also reported to occur in Japan, Philippine Islands, French South Africa, Jamaica, Sweden, Belgium, Syria, Mexico, and New Zealand.

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Plate I

Henderson talc mine, Madoc, Ont.; open pit and caved workings in foreground and new shaft (1914) in background.

Plate II

Talc mill of Geo. H. Gillespie Company, Ltd., Madoc, Ont.

LEGEND

Nº	Township	Range	Lot
1	Broughton	VII	14
2	Thetford	V	5, 7, 9
3	Inverness	I	1
4	Ireland, Craigs Rd.		2
5	Wolfestown	II	20
6	Melbourne	IV	23
7	Bolton	VI	24
8	Bolton	II	26
9	Potton	V	28
10	Potton	V	18
11	Potton	IV	17

Shaded portions represent approximately the principal Serpentine areas in the region. The productive asbestos district is confined chiefly to the three most easterly areas.

PRINCIPAL TALC AND SOAPSTONE OCCURRENCES
IN THE
EASTERN TOWNSHIPS
Quebec
Scale of Miles